GE
Sensing & Inspection Technologies

Eddy Current

Apollo™ Analysis

User's Manual

imagination at work

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Table of Contents

Table of Contents

Safety and Warranty Information 1

1.1 Safety Information

The Apollo™ was designed and tested in accordance with EN61010 Part 1, 2002 Safety Requirement for Electrical and Measuring, Control and Laboratory Use.

Before powering or operating this instrument, the following safety information information should be carefully read. This manual should be kept in a safe place for reference.

ATTENTION

This instrument is to be used only for materials testing in an industrial environment. Any use for medical applications or any other purpose is not permitted!

1.2 Software

Software is never completely free from errors. Before using any software controlled test equipment, please make sure that the required functions operate correctly perfectly in the intended combination.If you have any questions about the use of you test equipment, please contact the closest representative of GE Inspection Technologies.

NOTE: This software is developed to work properly on Windows™XP or newer.

1.3 Defects/Errors and Stresses

ATTENTION

If you have reason to believe that safe operation of your Apollo is no longer possible, you must disconnect the instrument.

DO NOT OPERATE IF:

- Instrument is visibly damaged.
- Instrument no longer operates correctly.
- Instrument has been stored for a prolonged period in adverse conditions.
- Instrument has been subjected to heavy stresses during transportation.

1.4 Important Information on Eddy Current Testing

Please read the following information before using your Apollo. It is important that you understand and utilize this information to avoid any operator errors that might lead to false test results. This could result in personal injuries or damage to property, along with larger sound velocity variations which could adversely affect the measuring accuaracy of the instrument.

1.5 Pre-Conditions for Testing with Eddy Current Testing

This operating manual contains essential information on how to operate your test equipment. In addition, there are a number of additional factors that affect test results, which are beyond the scope of this operating manual. This operating manual only covers the most important factors for a safe and reliable Eddy Current inspection, and operating training.

1.6 Warranty

Limited Service Warranty:

If, through our negligence, GE Inspection Technologies directly caused physical damage to your equipment while the equipment is in the sole custody and control of GE Inspection Technologies, we shall choose at our opinion either to repair the damage or replace the damaged portion of the equipment at our own expense, or to indemnify and hold you harmless for such physical damage to the Equipment. EXCEPT FOR THE WARRANTY SET IN THIS PARAGRAPH, GEIT EXPRESSLY DISCLAIMS ALL WARRANTIES AND REPRSENTATION OF ANY KIND WITH RESPECT TO OUR SERVICES OR THE INFORMATION CONTAINED IN ANY REPORTS THAT WE ISSUE TO YOU, WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NON-INFRINGEMENT, TITLE AND WARRANTIES ARISING FROM COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

Introduction and Installation 2

2.1 Introduction

Apollo is a multi-frequency eddy current inspection system. It is composed of the eddy current equipment (Apollo), a PC connected via network, and a computer application, which runs the data acquisition and analysis.

The Apollo system provides a complete line of software applications which includes eddy current data acquisition, data analysis, and data management (coming soon).

Apollo Analysis is one of the software applications created for eddy current data analysis of heat exchanger and condensers.

This guide applies to the Apollo Analysis application.

This chapter describes the hardware and software installation process for the Apollo Analysis system. It also describes the requirements for the installation and execution of the Apollo Analysis application.

2.2 Hardware / Software Requirements

The Apollo Analysis application has been designed for Pentium II or greater personal computers

A typical configuration would be as follows:

- Hardware identification key given by GE Inspection Technologies
- PC having the following minimum characteristics:
  14” color screen (17” recommended)
  SVGA video card (Configured to 256 colors or 16 bits).
  Pentium II /233 MHz CPU
  ISA/PCI BUS
  850 Mbytes hard disc 64 Mbytes of RAM
  (128 Mb recommended)
  Mouse
  Keyboard Interfaces
  RS232 or parallel, for printers
  USB ports for the hardware key

The Apollo Analysis application has been developed for WINDOWS XP or newer:

2.3 Peripherals

STORAGE DEVICES

The Apollo analysis application reads eddy current data files previously recorded using the Apollo-ACQ program. These data files can be stored in almost any memory device common on the market today: Cd-Rom, USB storage device, hard disks, etc.

The Apollo Analysis application permits the reading of additional eddy current data such as Miz-18 files.

PRINTERS

A laser printer is suggested for the Apollo Analysis application.

2.4 Installation of the Apollo Analysis Application

SETUP

The installation of the Apollo Analysis application is done using CD-ROM. Place the CD into the appropriate drive. The CD will automatically start if autorun is enabled. If not, the following command must be used from Windows Explorer:

Ex: “D:\setup.exe”

Follow the onscreen instructions to install the application.

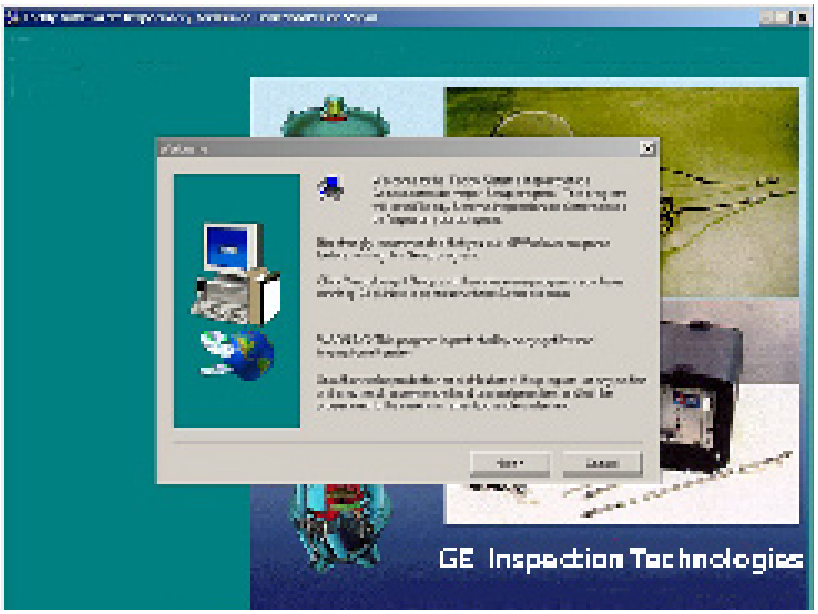


Figure 1 Presentation of Installation

FILE SYSTEM

The file system generated by the Apollo Analysis application corresponds to the following structure.

EXTENSION	MEANING
*.inf	Extension for the Report files.
*.men	Extension for message files.
*.clb	Extension for calibration files.
*.cgr	Extension for calibration files.
*.tcfg	Extension for Teddy equipment configuration.
*.ecd	Extension for data acquisition files.
*.plf	Extension for inspection summary files.
*ancc	Extension for evaluation set up files.

The Apollo Analysis application is executed by double clicking on the corresponding icon with the left mouse button:

Figure 2 Application Icon

The application can also execute via the appropriate selection in the Programs menu. .

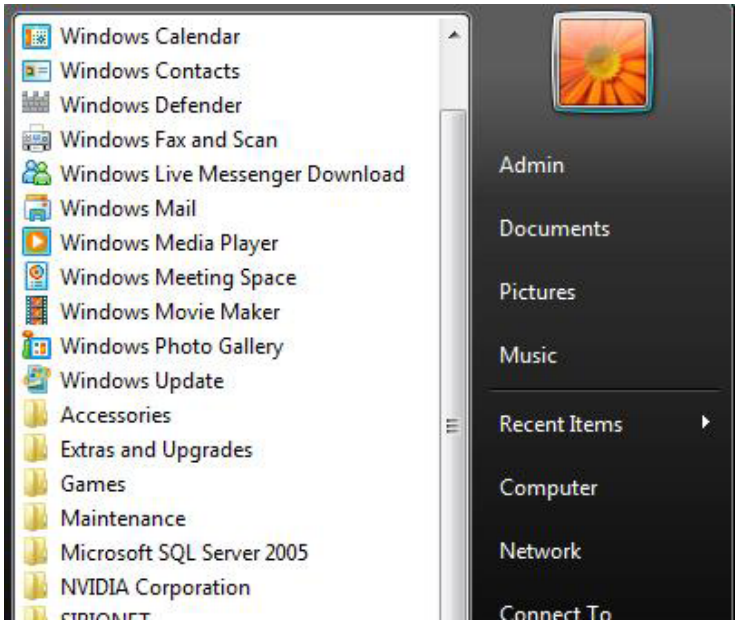


Figure 3 Desktop

GENERAL DESCRIPTION

The Apollo Analysis is one of the software applications developed as a part of the Apollo software suite of programs, which at the present time, consists of acquisition and analysis software, with data management software being developed.

Its basic objective is the eddy current data analysis and basic report generation. Apollo Analysis was designed to allow the analysis of large numbers of tubes in either a stand-alone or networked data room. To assist in this, a series of tools have been included in this package.

Special attention has been paid to the automation of the analysis processes so that the user can optimize their work reducing the analysis time.

When the application starts, the user must create an analysis plan which can defined as part of the setup. For instance: the device where the data to be analyzed is located/ stored, whether there is or is not historical information from previous inspections, whether the type of analysis that is being preformed is or is not being conducted in a coordinated mode, if an external Data Base is being employeed, and whether the analysis mode is normal analysis or supervision.

The application offers several graphical representations of eddy current data:

Alphanumeric — Allows the visualization of all the different raw channels and encoder channels.

Stripchart— A streaming display of a channel component (vertical or horizontal).

Lissajous — A representation of the complex plane of the two components of a channel.

Diagnostics Window— In this window there are general data related to the display of the samples and signal measurements.

Calibration Curves — Representation of the calibration curves for the frequencies being used.

VIEW 1D

This representation allows the user to select the magnitude that they want to display in the ordinate axis (vertical component, horizontal, module, filters, etc…) and in the abscissa axis. The sample range is shown from the first to the last.

The users can configure their screen layout (or graphic configuration) and then store it on disk in order to recover it later. The possibility of presenting a number of fixed graphic configurations is also offered (2 stripcharts + 2 lissajous, 4 stripcharts, etc.). These configurations have been considered to be the most common for the users.

The following information (analysis plan, graphic configuration, calibration parameters) constitutes a part of what is called the setup or analysis configuration.

Data analysts rely on a series of tools that make analysis easier, such as automatic recognition of supports, component specific indication lists that automate the process of reporting an indication or a defect, the visualization of historical information on-line (if a historical data base is being used), different displays of the signals of interest, result report windows, etc.

Menus 3

3.1 File Menu

The file menu is divided into several sections: file operations, printer options and previous files analyzed. The menu options are:

Figure 4 File Menu

Open — This option opens a file manager permitting the analyst to select a data file in order to analyze it with Apollo Analysis.

Read — Reads a data file. The difference from the previous option is that the current file (the one the analyst is working with) is substituted by the file read.

Save as — This option allows the user to save a file with a different name. (Recommended for lab work only)

Close — It is used to close the current file.

Note: **The options Open, Read, Save as and Close can be useful at an experimental level or for the laboratory, but they are not intended for use during actual inspection.**

Print — This option allows the user to print displays of the current data file.

Preview — This gives a preview of the printout that it is going to be obtained.

Print Setup — This opens the standard Windows printer configuration window where the printer properties can be chosen.

Page Setup — This option is only available if there is a data file open. It opens a window in which the type of print-out by default can be chosen.

3.2 Analysis Plan Menu

Through this menu, the analyst can display information related to the analysis plan, historical information, table of analysis results and so on. The menu options are:

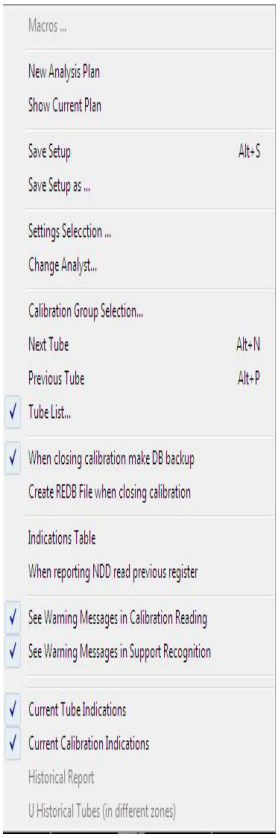


Figure 5 Plan of Analysis Menu

Macros — Not available at this time.

New Plan of Analysis — Used to create a new analysis plan in which the analyst can set certain parameters that define the process of data analysis process.

Show Current Plan — Opens the analysis plan window with the purpose of displaying the plan parameters.

Save Setup — This option allows the analyst to save the current configuration into a setup file. The configuration includes the parameters of the analysis plan, the configuration of all the displays of the data base, support recognition parameter, graphic configuration, calibration files, and indication definition tables. This setup file is read by default when starting the application.

Save Setup As — Allows the analyst the ability to use unique setup files with each component being inspected.

Settings Selection- Allows Analyst to set the Directory storage path for all setup files.

Change Analyst — This option allows for the ability to change the analyst during the analysis process.

Calibration Group Selection —Opens the Calibration group window where the user can select the calibration group that is going to be analyzed.

Next Tube — Reads the next tube file in the cal group.

Previous Tube — Reads the previous tube file in the cal group.

Tube List — Used to show/hide the tube index (list) of the current calibration group.

When closing calibration make DB Backup — Makes a backup of the database file when the current calibration group is closed.

Indications Table — Displays the window with the list of indications (three letter codes) that can be used during the analysis process. This window also allows the user the ability to configure the indications.

When reporting NDD read previous register — Allows the user to read the previous file when a tube is considered as NDD (this option is useful when analyzing the list of tubes in reverse order)

See warning messages in calibration reading — When this option is enabled warning messages will be shown if there are any errors when a calibration file (*.clb) is read.

See warning messages in support recognition — When this option is enabled the possible errors during the process of support recognition will be indicated by means of warning messages.

Current tube indications — This option shows/hides the window with the list of indications reported in the current tube being analyzed.

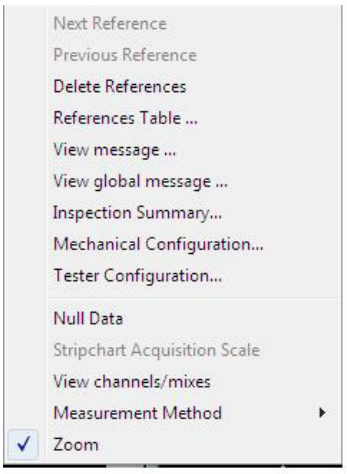
Current calibration indications — This option shows/hides the window with the list of indications reported in all the tubes of the calibration group.

Historical report — If working with historical information, this option shows/hides the window with the list of “historical” indications reported for the current tube.

NOTE: Historical (U-Bend) Tubes (in different zones)- Displays historical information from the opposite plenum when analyzing data in the straight section of a U-Bend component.

3.3 Document Menu

This menu is present whenever a document is available (data file). The menu options are:



Next Reference — Places the cursor on the position of the next reference indication closest to the current position of the cursor.

Previous Reference — Places the cursor on the position of the previous reference indication closest to the current position of the cursor.

Delete Reference — Eliminates all the reference indications made on the graphical representations.

Figure 6 Document Menu

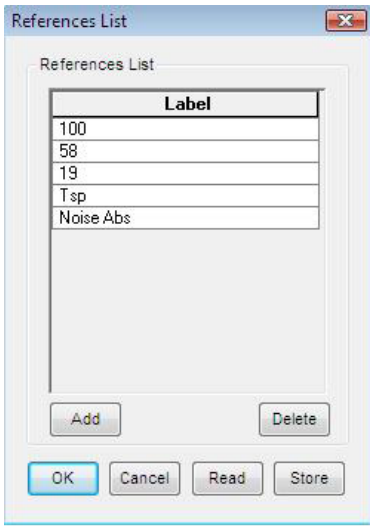


Figure 8 Reference List

View Message — Shows a window for the messages associated with a tube.

View Global Message — Shows the global messages window.

Inspection Summary — Opens the inspection summary which contains information on the acquisition process.

Mechanical Systems — Shows the window with the mechanical systems used during the acquisition process.

Tester Configuration — Opens the window that contains the configuration of the eddy current acquisition equipment used to acquire the current data.

Null Data — Balances the data channels and mixes with respect to the value of the sample at which the cursor is located.

Stripchart Acquisition Scale — Not active in Apollo Analysis.

View channels/mixes — The channels and mixes window is displayed.

Measurement Method — Allows the evaluation mode of the measurement points on the lissajous window to be chosen. This mode will be later described in chapter 7.

Zoom — Enabling this option the visualization area of the stripcharts will be zoomed with the factor selected in the zoom toolbar taking as a reference the current position of the cursor. If the option is disabled the zoom factor will become 1.

3.4 Calibration Menu

This menu allows the analyst access to the different calibration tools.

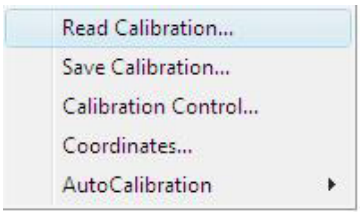


Figure 9 Calibration Menu

Read Calibration — Opens a file selector to read a previously saved calibration file.

Save Calibration — Opens a file selector to save the current calibration in a calibration file.

Calibration Control — Displays the calibration control window.

Coordinates — Shows the page corresponding to the calibration of coordinates in the calibration control window.

Auto Calibration — Opens a window for user-defined auto-calibration parameters.

3.5 Supports

By means of this menu, the different options for the recognition of the components structures (supports) in the heat exchanger are available.

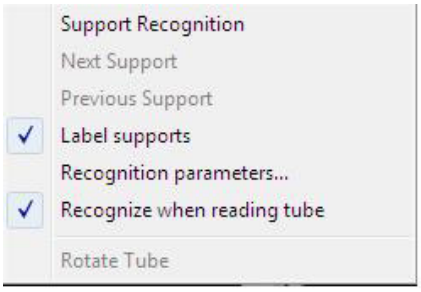


Figure 10 Supports

Support recognition — Executes the process of support identification.

Next support — The cursor moves to the next recognized support.

Previous support — The cursor moves to the previous recognized support.

Label supports — Labels the supports that have been detected in the stripchart.

Recognition parameters — Opens a dialog window where the user can specify the parameters for support recognition.

Recognize when reading tube — Performs the support recognition process whenever a new tube is read.

Rotate tube — Inverts the graphical representation of tube signal.

3.6 View Menu

This menu permits the user the ability to activate or deactivate various display options.

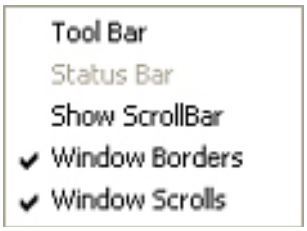


Figure 8 View Menu

Tool Bar — Opens a configuration window indicating which toolbars may be displayed, allowing the tool bar to activate or deactivate them and select the size of the icons (big or normal).

Status Bar — Shows/hides the status bar.

Show Scrollbar — Shows/hides the application scrollbar.

Window Borders — Shows/hides the borders of the windows used for graphical representation of the eddy current signals.

Window Scroll — Shows/hides the scrollbars of the windows used for graphical representation of the eddy current signals.

3.7 Window Menu

This menu is used for controlling the different data representation windows.

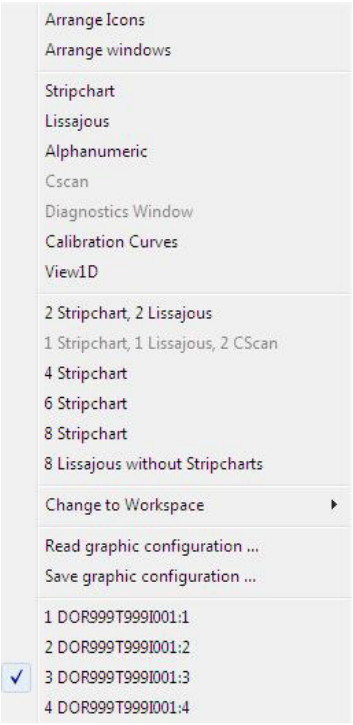


Figure 11 Window Menu

Arrange icons — Used to organize the icons of the windows.

Arrange windows — Used to organize the signal representation windows on a screen

Stripchart — Places a stripchart window on the screen.

Lissajous — Places a lissajous window on the screen..

Alphanumeric — Shows an alphanumeric window.

Cscan — Displays a Cscan window.

Diagnostics windows — Shows a diagnosis window.

Calibration curves — Shows the window for the graphical representation of the calibration curves made for the different channels and mixes.

View 1D — This shows a 1D window.

The users may design a configuration of windows and save this configuration using the save setup option. The configurations may be restored and shared with any Analysis workstation.

There is also a series of predefined screens that the user may select from. Included are: 2 stripcharts + 2 lissajous, 4 stripcharts, etc.

Change to Workspace — Allows the analyst the ability to change to one of the six available working area.

Read graphic configuration — Allows a saved graphic configuration to be read.

Save graphic configuration — Allows the user the ability to save the current configuration of the windows in a graphic configuration file.

Toolbars 4

4.1 Main Toolbar

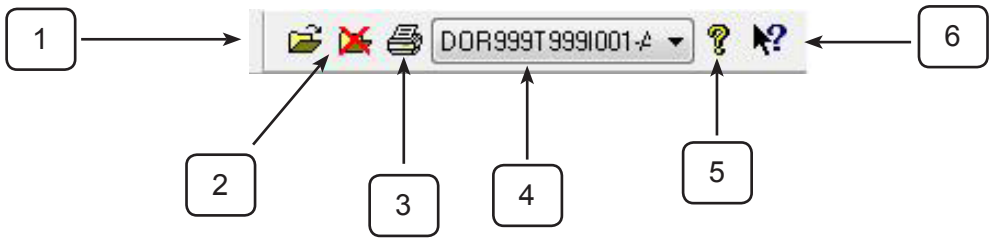


Figure 13 Main Toolbar

1. **Open a new file** — Opens a file selector so the user can choose a data file to be read. It is the equivalent to Open in the File menu.
2. **Close** — Closes the current data file.
3. **Print** — Prints the selected active documents. It is equivalent to the Print command in the File menu.
4. **Current File** — Label that indicates the name of the current data file.
5. **About** — Activates the About option of the Help menu.
6. **Help** — Activates the Help items option of the Help menu. Future revisions will open the Apollo Analysis manual.

4.2 Document Toolbar

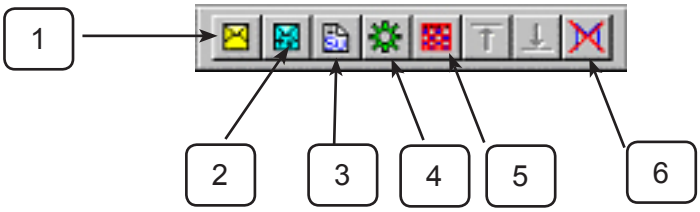


Figure 14 DocumentToolbar

1. View Global Messages — The global message window is shown.
2. View Associated Messages — The messages associated with the current tube are displayed.
3. View Inspection Summary — The Inspection Summary window is displayed.
4. View Mechanical Systems — The mechanical systems window is displayed.

5. **Acquisition System** — This is the window displaying the configuration of the acquisition system is shown.
6. **Delete All References** — This erases all references.

4.3 ET Operations Toolbar

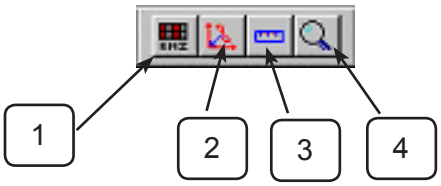


Figure 15 Eddy Current Operations Toolbar

1. **Channels and Mixes** — The channels and mixes information window is displayed.
2. **Compensate all the Channels** — This option balances (nulls) all eddy current data channels.
3. **Fix Stripchart Scale** — This establishes the acquisition scale for the stripcharts. (Acquisition function only)
4. **Zoom** — Selecting this button allows the user to zoom data at predefined zoom levels fixed within the software.

4.4 Measurement Modes Toolbar

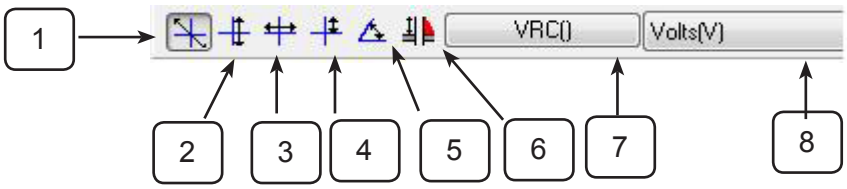


Figure 16 Measurement Toolbar

There are six different modes available. For each one, the amplitude in volts is given, as well as the angle of the signal in degrees and the position of the indication (in mm or inches) with respect to the reference support (if any support recognition has been previously invoked).

1. **VPP Mode** — Changes to Peak to Peak Voltage mode. For differential channels, the most remote data points are selected (points contained in the lissajous window) and the value in volts, as well as the angle between the points, are calculated. In absolute mode, one of the data points is fixed coinciding with the upper edge of the cursor window and the other will be the farthest data point from the previous one. As in differential mode, the volts and the angle will be calculated..
2. **VVM Mode** — Maximum Vertical Volts mode. In this measurement mode, the most remote points in the vertical component are searched, both in differential and absolute mode. The value in volts as well as the angle of the segment that links both points are calculated,
3. **VHM Mode** — Maximum Horizontal Volts. In this measurement mode, the most remote points in the horizontal component are searched, both in differential and absolute mode. The value in volts as well as the angle of the segment that links both points are calculated.
4. **VMP Mode** —Positive Measurement Volts mode. That is, the measurement from the vertical mean value to the vertical maximum positive value.
5. **MaxRate Mode**- Measures the maximum rate of transition displayed in voltage and degrees
6. **AMP Mode** —Changes to Maximum Slope Amplitude mode. This measurement is similar to VPP with the difference that the calculated angle belongs to the segment that links the extremes of the three most remote consecutive samples. The value in volts is the same as in the VPP mode.
7. **Selection of the Measurement Curve** — This selects the type of calibration curve that is applied to the measurement:

    -Volts(V): voltage curve.

    -Ang Dep(%): phase-depth curve.

    -Amp Dep(%) : amplitude depth curve.

4.5 Calibration Toolbar

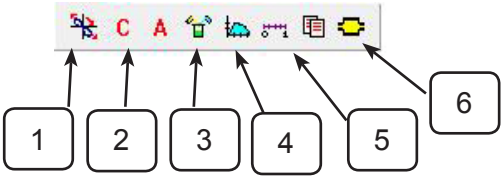


Figure 18 Calibration Toolbar

1. **Calibration of Channels** — Shows the calibration control on the page corresponding to the calibration of channels and mixes.
2. **Channels**- Shows all raw and mix channels.
3. **Automatic**- Edit, recall, create and execute AutoCalibration.
4. **Mixes Calibration** — Shows the calibration control on the page corresponding to the creation of mixes.
5. **Curves Calibration** — Shows the calibration control on the page corresponding to the creation of the different calibration curves.
6. **Coordinates** — Shows the calibration control on the page corresponding to the calibration of coordinates.
7. **Duplicate Channel** — Shows the calibration control on the page corresponding to the duplication of channels
8. **Filtered Channel** — Shows the calibration control on the page corresponding to the generation of filtered channels

4.6 Work Area Toolbar

Figure 19 Work Area

This toolbar activates the various work areas.

4.7 ReTest ToolBar

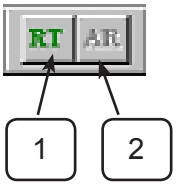


Figure 20 ReTest Toolbar

1. **Retest** — Opens the Retest validation window.
2. **Cancel Retest** — Deactivates the Retest option.

4.8 Toolbar Close

Closes the calibration group.

Figure 21 Close Calibration

4.9 Next Previous Toolbar

Used to read the tubes in the calibration group in ascending or descending order.

Figure 22 Next Previous

4.10 Report Toolbar

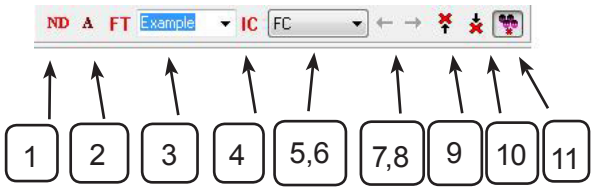


Figure 23 Report ToolBar

1. **NDD** — Enters NDD code (No Defect Detected) into the final report.
2. **Current** — Reports the selected signal with the cursor in the active signal (lissajous).
3. **From / To** — Enters an axial range of degradation into the Calibration Report.
4. **Defect Type** — List with the types of defects or indications that can be reported.
5. **Report Calibration Start** — Enters the start of calibration in the Calibration Report.
6. **Report Calibration End** — Enters the end of calibration into the Calibration Report.
7. **Finish (previous)** the analysis of this tube and read the previous one.
8. **Finish (next)** the analysis of this tube and read the next.
9. **Go to the next** defect in current tube.
10. **Go to previous** defect in the current tube
11. Show defects of all analysts.

4.11 Support Toolbar

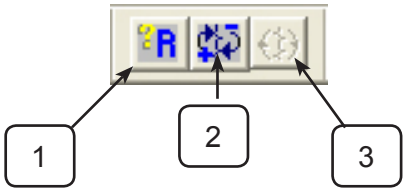


Figure 24 Support ToolBar

1. **Support Recognition** — left-clicking this button will initiate the support recognition process. Right-clicking this button will open the support recognition parameters control.
2. **Next/previous support** — Left-clicking, the cursor will be moved to the next support. Right-clicking will move the cursor to the previous support.
3. **Rotate tube** — Inverts the visualization of the signal representation.

4.12 Zoom Toolbar

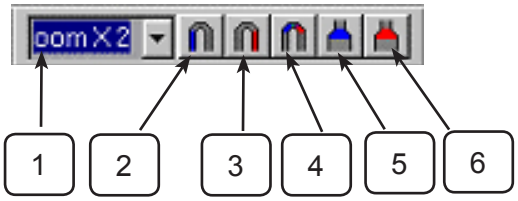
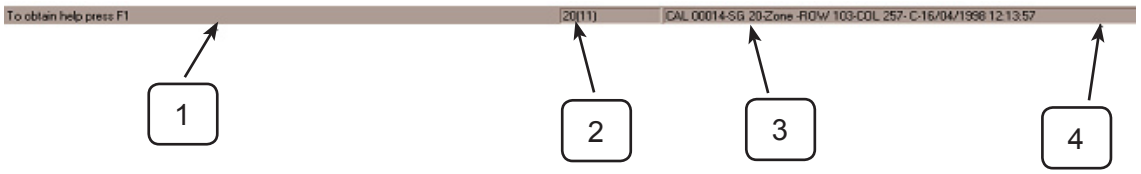


Figure 24 Zoom Toolbar

1. **Zoom** — Allows the user to select different magnification factors.
2. **Cold Leg** — Applies a zoom to the cold leg area section of the displayed data.
3. **Hot Leg** — Applies a zoom to the hot leg section of the displayed data.
4. **Curved Zone** — Applies a zoom to the U-bend section of the data.
5. **Cold Leg Expansion Zone** — Applies a zoom to the expansion of the cold leg.
6. **Hot Leg Expansion Zone** — Applies a zoom to the expansion of the hot leg.

4.13 Status Bar

The status bar shows different messages and information.



1. **Messages/Help** — Informs the users of the functions of the various button functions on the toolbars and offers certain application actions.
2. **Cursor** — Displays the sample where the cursor is located together with the size of the data cursor (in samples) of the stripcharts associated with the lissajous.
3. **Identification** — Consists of data related to the current file.
4. **Keyboard Information** — Zone reserved to show if certain keys are activated, as the capital key(MAY) the BLOQ Num (NUM), etc.

Inspection Summary 5

5.1 Introduction

This is the summary window which specifies the general inspection information. In data analysis mode the window shows the information recorded in each acquired tube.

The window has a total of nine pages, each one containing information relative to the company conducting the inspection, the equipment used in the inspection, the instrument operator, the calibration standards used, the component to be inspected and the probes used for the data acquisition. Following is an explanation of the content of each one of these.

At the bottom of the window there is a set of buttons which have the following functions:

Read — Permits the analyst to view the acquisition summary.

Save — Allows a inspection summary file to be saved and recovered later.

Print — Allows the inspection summary that is being carried out to be printed.

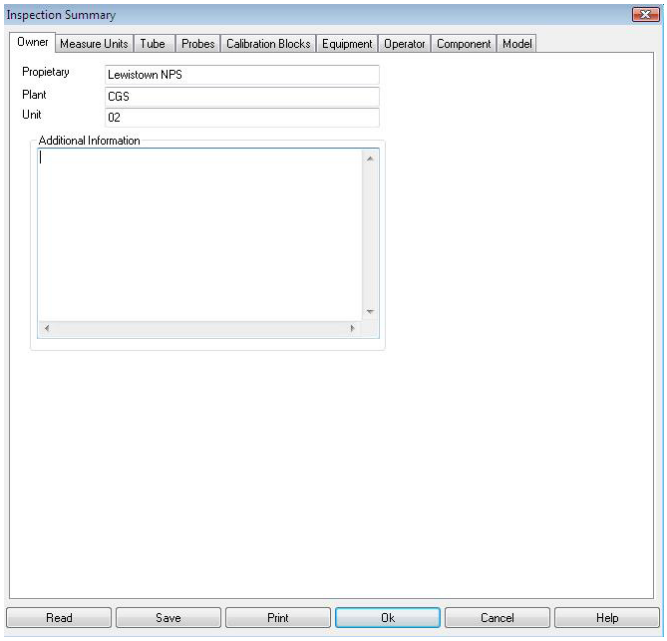
Accept — Closes the window and updates all the changes made.

Cancel — Closes the window without updating the changes made.

Help — Shows the help available for this window.

5.2 Owner

Information relative to the client and required by the Apollo Analysis system service is introduced on this page.



The data relative to the client is as follows:

Proprietary — The name of the plant/utility requiring the inspection.

Plant — The name of the plant where the service is to be carried out.

Unit — The identification of the unit in which the service is to be carried out when more than one unit exists.

Figure 27 Owner

5.3 Measure Units

This page is used to specify the measuring units applicable for the inspection being performed.

Two different areas can be seen in this window:

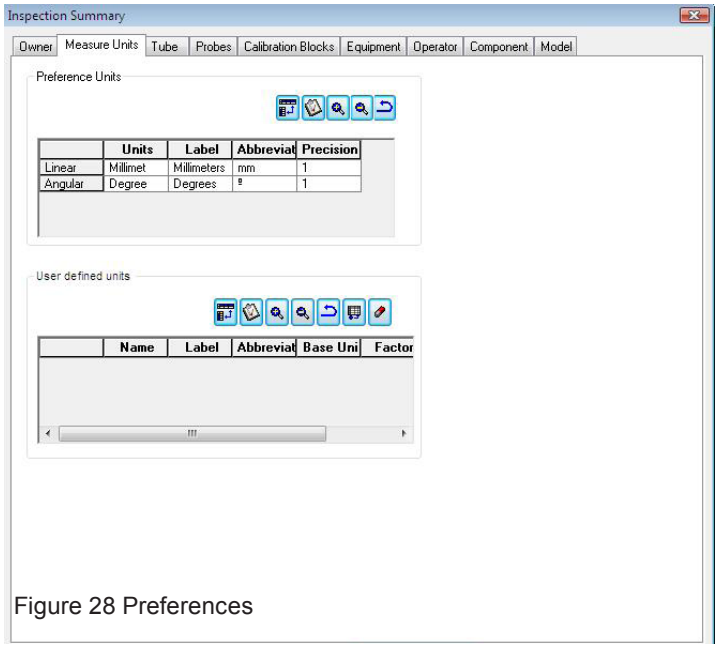


Figure 28 Preferences

Preference Units

In this section it is possible to choose different types of unit grouped together in:

Angular Units —Shows the possible units to be chosen for counting degrees or radians.

Linear Units —Shows the possible units to be chosen for counting millimeters or inches.

Label —Shows the label associated with the units chosen.

Abbreviation —Shows the abbreviation associated with the units chosen.

User Defined Units

Data to be filled in by the user:

Name
Label

Abbreviation
Base Unit
Factor

Both areas have a set of buttons for working with the different fields, change rows for columns, see fields, zoom, and readjust the width of the columns to their initial size.

Two additional buttons appear in the second area and are used for creating and eliminating new data input.

5.4 Tube

This page shows the details of all the data related to the tubes to be inspected.

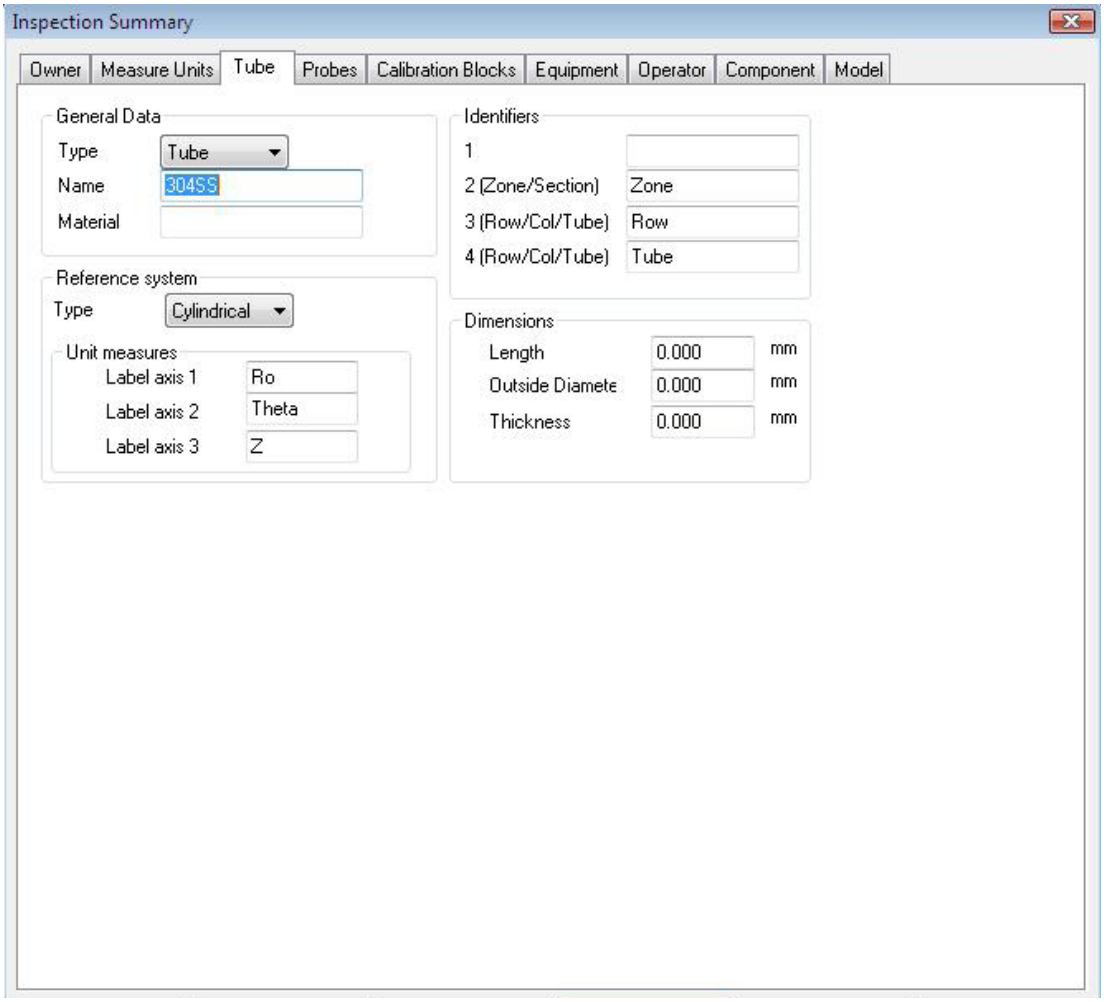


Figure 29 Tube

This page has four different areas: General Data, Dimensions, Identifiers and Reference Systems.

The data for each one of these areas is as follows:

General Data — The type of component to be inspected; this may be a Tube, a Plane or another item other than tubing requiring inspection.

Identifiers — A piece may use up to a total of four identifiers and an attribute will be given to each piece. In this field, a specification is given to the content of each piece.

Dimensions — In accordance with the piece, this is a specific value for the radius, angle, and thickness. If the test specimen is a flat piece or a piece of a different kind, length, and outer diameter, or is a tube.

Reference System — This shows which of the reference systems are being used, Cartesian or Cylindrical.

5.5 Probes

This page is used to specify the characteristics of the probe required for the inspection.

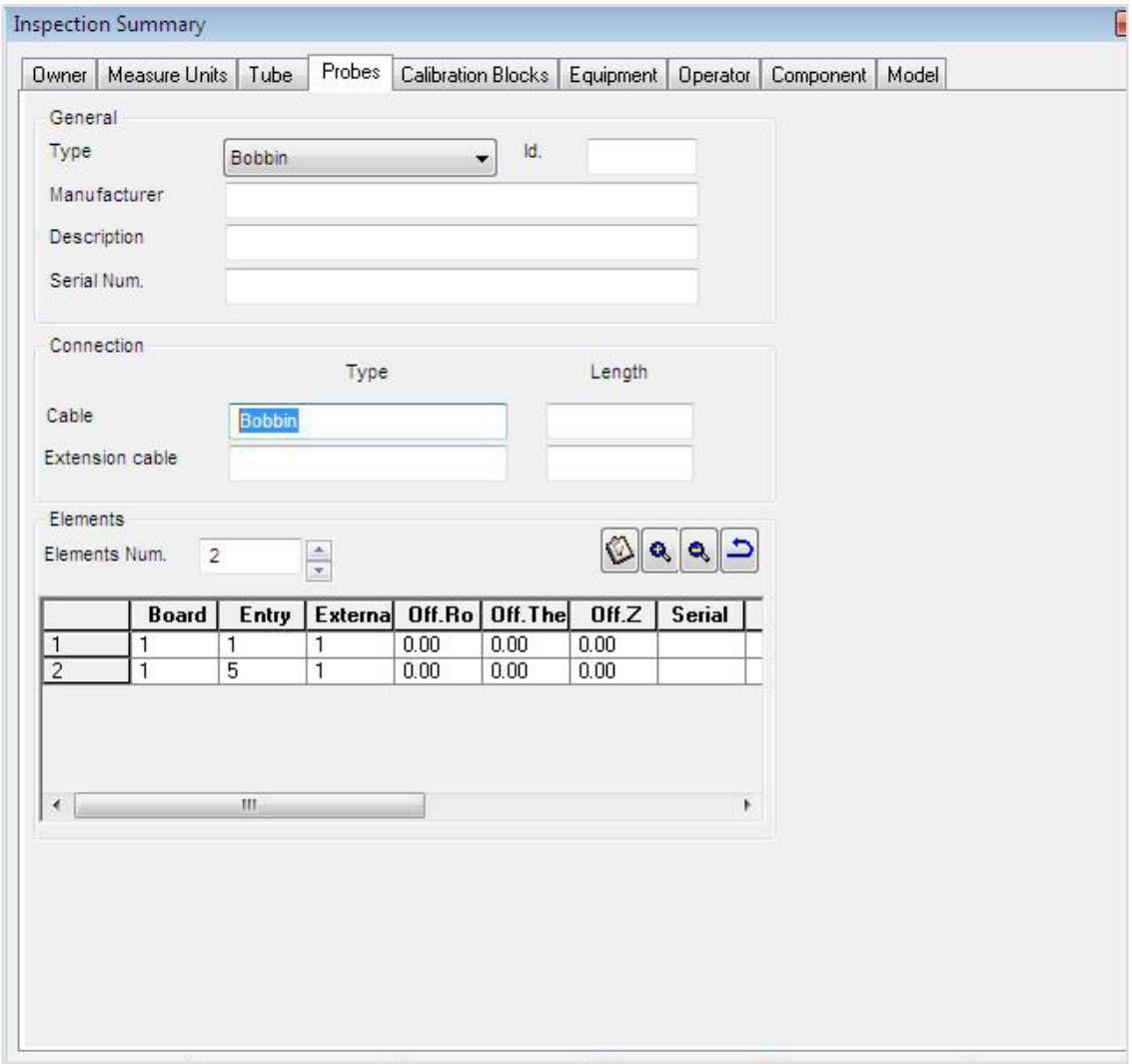


Figure 30 Probes

This page has three different areas:

General — This contains general information on the probe used in the inspection.

Type — The type of probe to be used, Bobbin, Profilometry, MRPC Support, MRPC Tubesheet, Pancake, Blade or General.

Identification — Item Number of the probe.

Manufacturer — Manufacturer of the probe.

Description — Identification code of the probe.

Serial Number — Serial number of the probe.

Connection

Type of cable — Type of connection cable and length.

Type of extension cable — Type of extension cable and length.

Elements — This specifies the number of elements or coils of the probe. It also shows a table where it is possible to edit the properties of each one by double clicking with the mouse on the corresponding cell.

These properties include:

1. **Entry —** This indicates the input being used by the coil in the Apollo.
2. **Exploration Offsets —** The distance between the coil and a fixed reference in the probe in the sense of the exploration axis is expressed in the units assigned to the axis in the Mechanical System dialog.
3. **Overlapping Offsets —** The distance between the coil and a fixed reference on the probe in the sense of the overlapping axis is expressed in the units assigned to the axis in the Mechanical System dialog.
4. **Serial Number —** The number which identifies the element.
5. **Type —** Type of coil used to carry out the inspection.

5.6 Calibration Blocks

The data corresponding to the calibration blocks are as follows:

Number — Number of calibration standards used for the inspection of a given component.

Name — The type of calibration standards being used.

Identifier — The serial number of each of the calibration standards used in a given inspection.

5.7 Equipment

Data pertaining to the test instrument to be used in the inspection.

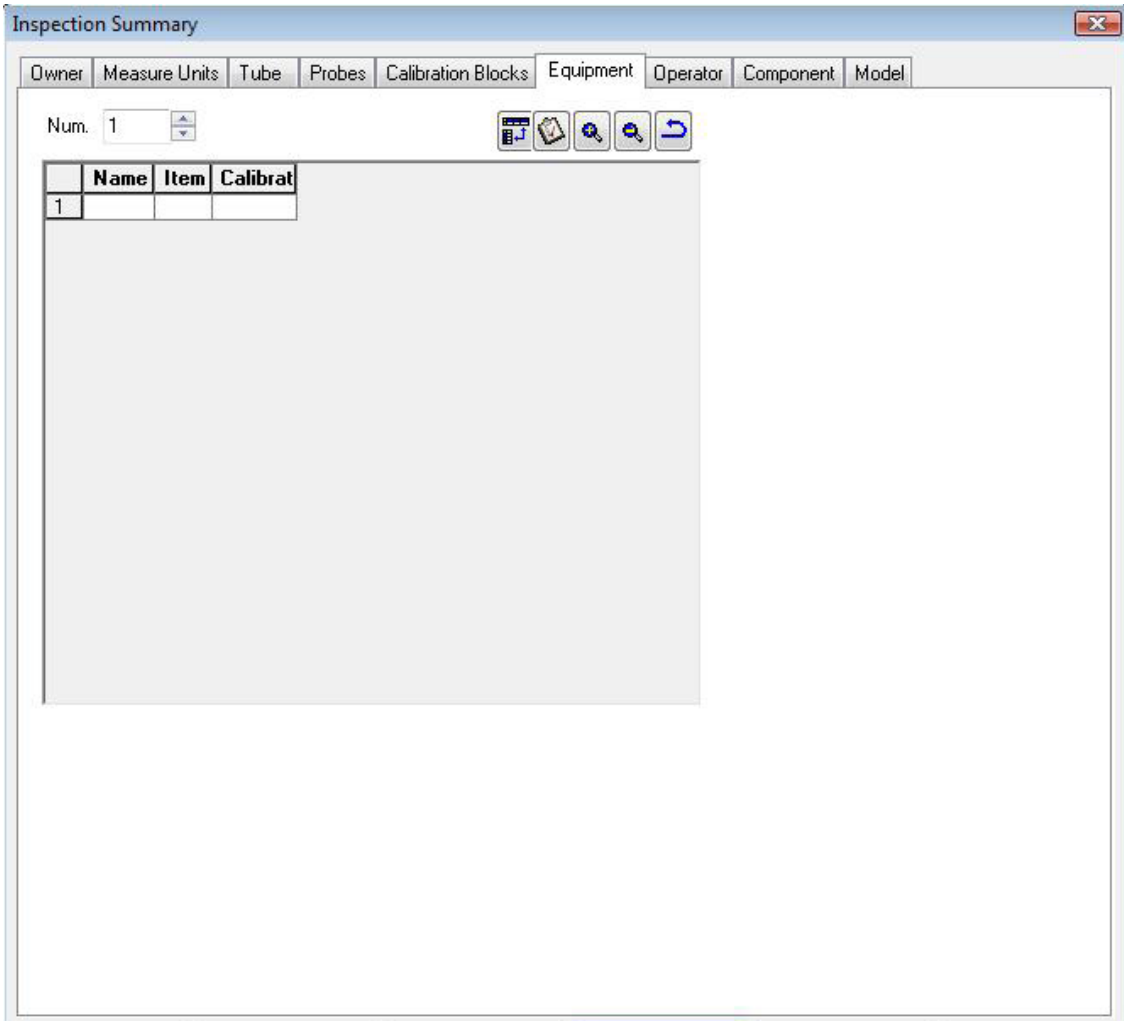


Figure 32 Equipment

The data regarding the equipment is as follows:

Number — The numbering of the different instruments used in the inspection or test.

Name — The name of the instrument.

Item — The serial number used to identify each piece of equipment.

Calibration Date — The date of the calibration expiration for the instrument being used.

5.8 Operator

This page is used to record the data regarding the operator(s) performing the inspection requested by the client.

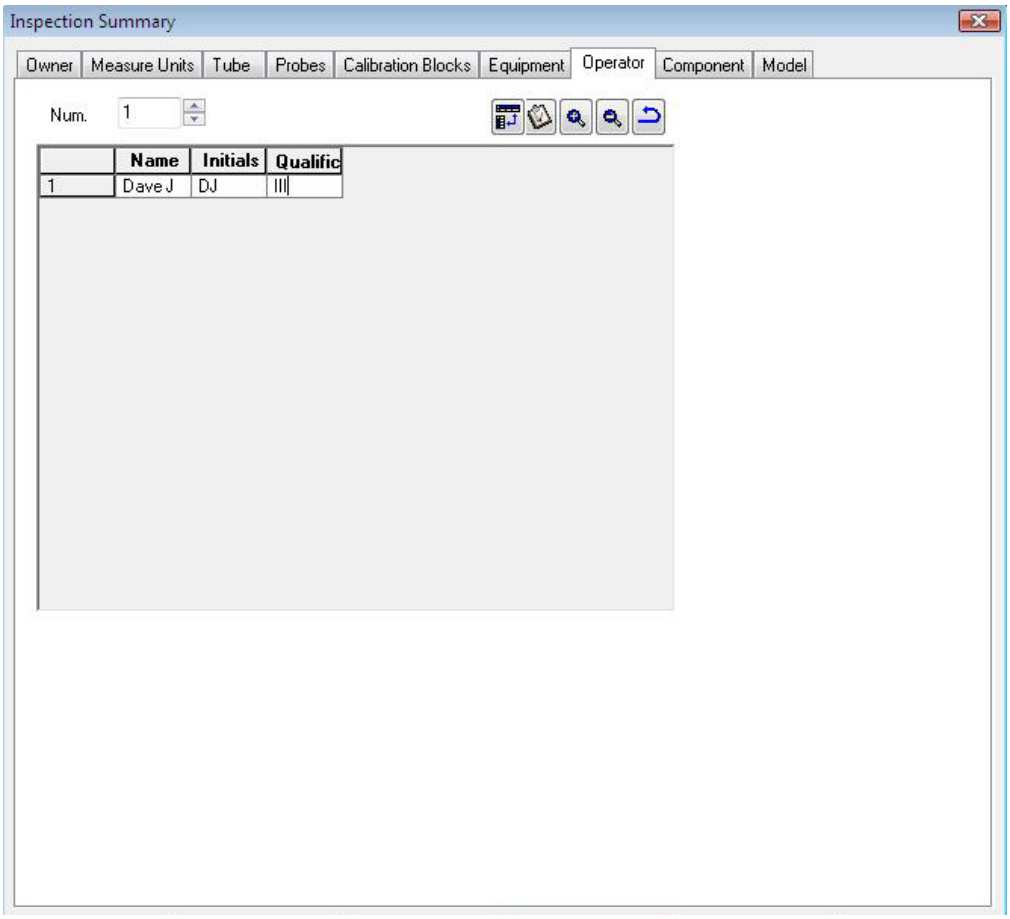


Figure 33 Operator

The data regarding the operator is as follows:

Number — The number of operators working on the cal.

Name — The name of the operator.

Initials — Initials of the analyst.

Qualification — The qualification level of the operator.

5.9 Component

Data regarding the component to be inspected is introduced on this page.

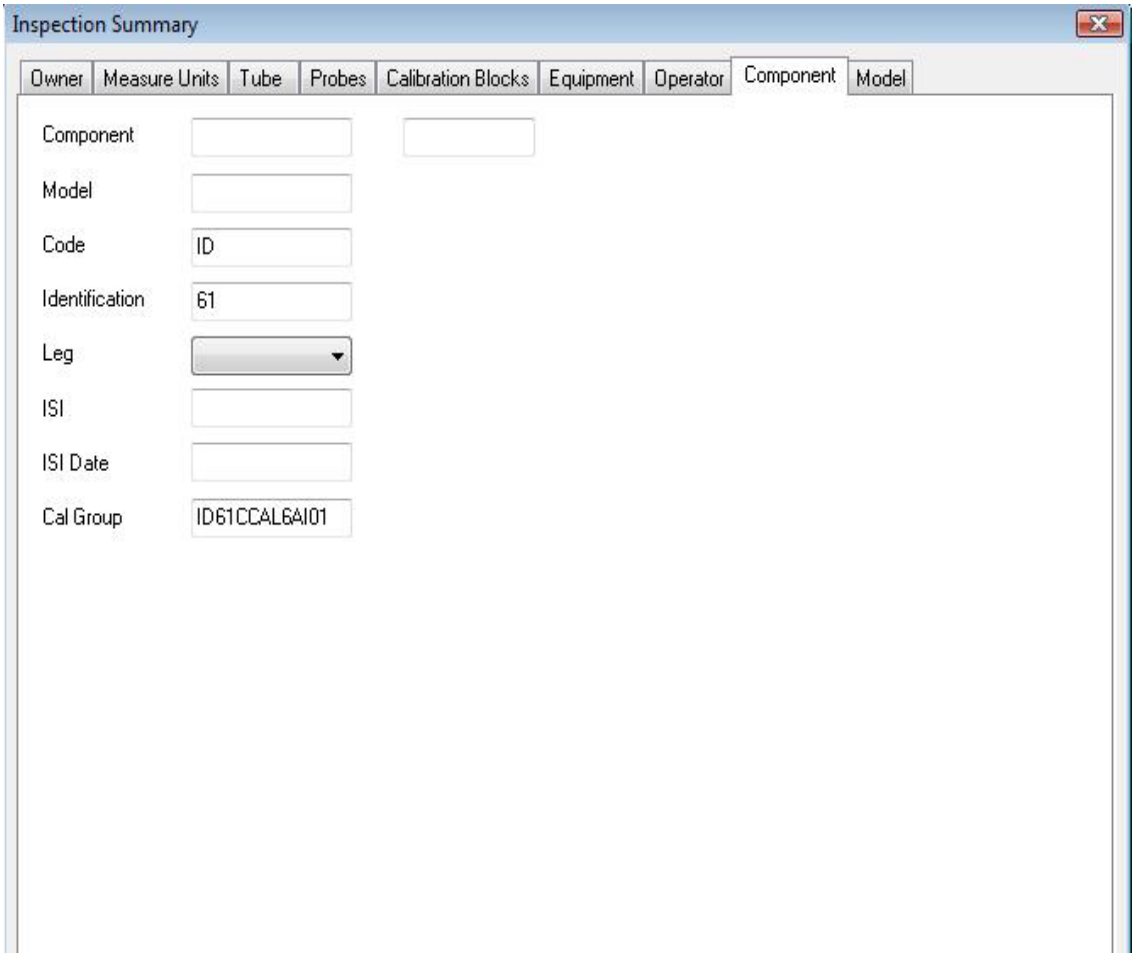


Figure34 Component

The data regarding the component is:

Component — Name or type of the component being tested.

Model — Name of the heat exchanger model.

Code — Code that defines the component to be examined, for example HX.

Identification — Identification of the component.

Leg — Leg in which the inspection is conducted.

ISI— Number that identifies the inspection being conducted.

ISI-Date — Date in which the inspection is conducted.

5.10 Model

This page is used to specify the landmark data of the component that is going to be inspected.

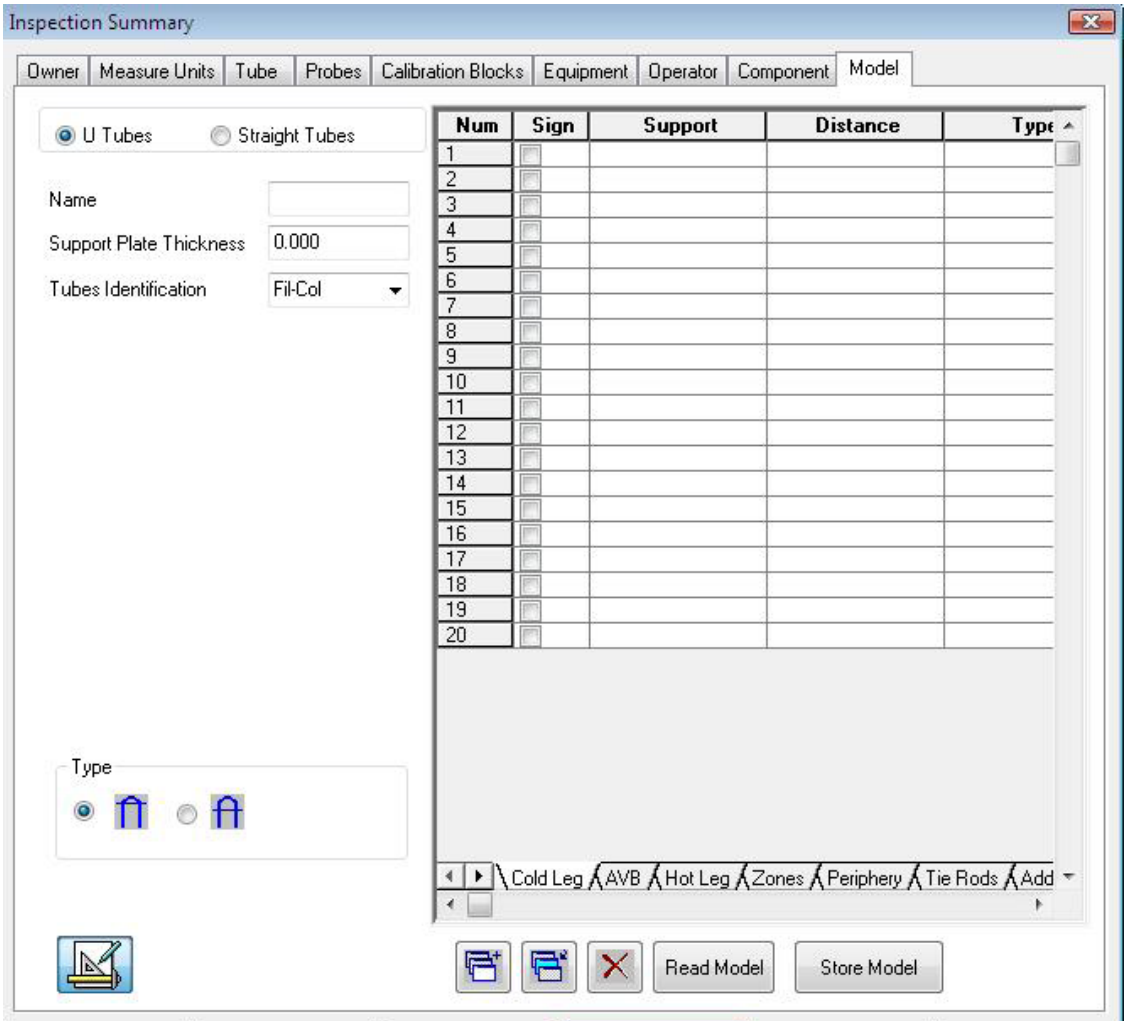


Figure 35 Model

There are two zones in this window; one regarding general data and the other consisting of a series of pages in which the information concerning the existing structures in the model and data regarding the tube map is introduced. In the lower right side of the window model there are two buttons for reading and saving the information corresponding to the model in files (*.mod).

1. **General Data**

   Type of Tube — Specify if the tube is going to be a tube in U or a straight tube.

   Name — Name assigned to the model of heat exchanger.

   Support Plate — Thickness in measurement units of the supports plate.

   Tubes Identification — The tubes identification as Row-Column or Column-Row is set here.

   Type — The type of component is established here and can belong to one of the following:

Vertical Steam Generator: after the last support plate of the generator, the curved section starts (for example, model type D3)

Vertical Steam Generator, a straight section exists after the last support plate of the generator before the beginning of the curved section (for example model type F)

2. **Model Structure**

   Consists of 7 pages. The first three, Cold Leg, AVB and Hot Leg describe the support structures of the generator. The next two, Peripheral and Tie Rods, serve to define the bundle layout. Finally the Additional Data page shows information that depends on the type of generator model chosen.

   The first six pages are organized as a table and have buttons located at the bottom of the page in order to add, insert or delete rows.

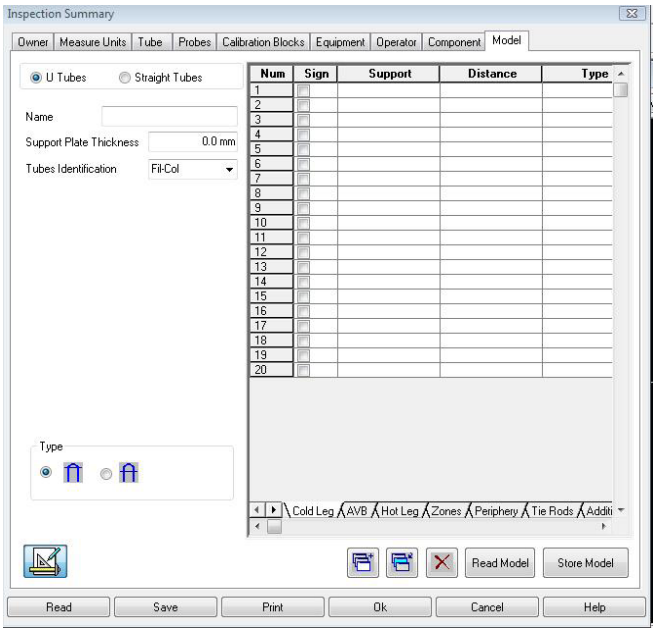


Figure 36 Cold Leg

Cold Leg — Consists of six fields:

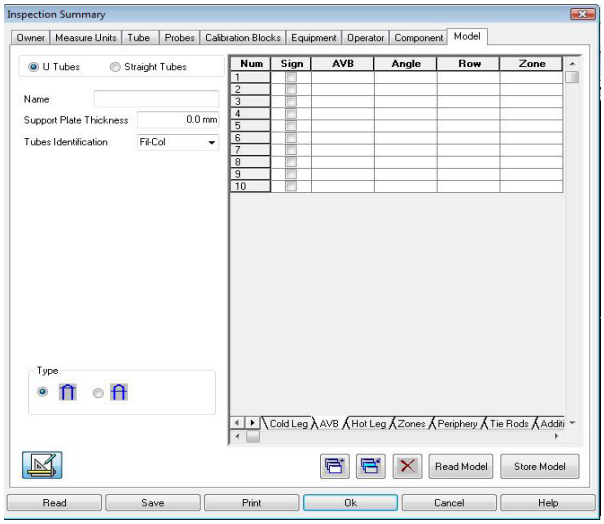
Sign, Support, Distance, Type, Thickness and Zone.

Used for describing the characteristics of the structures corresponding to the Cold Leg of the component.

The first field, Sign, identifies the point of sign change in the localization information of a signal with regards to a support plate. In previous versions, this point was located in the last support of cold leg. With this option is possible to specify which support corresponds to the point of sign change in referencing reportable indications

in the proper direction from a structure. Only one support should be marked as point of sign change.

Support and Distance are compulsory for support self recognition.



AVB—Consists of five fields:

Sign, AVB Label, Angle, Row and Zone.

The parameters **Angle and Row** are used to calculate the distances existing between the AVB.

Figure 37 AVB

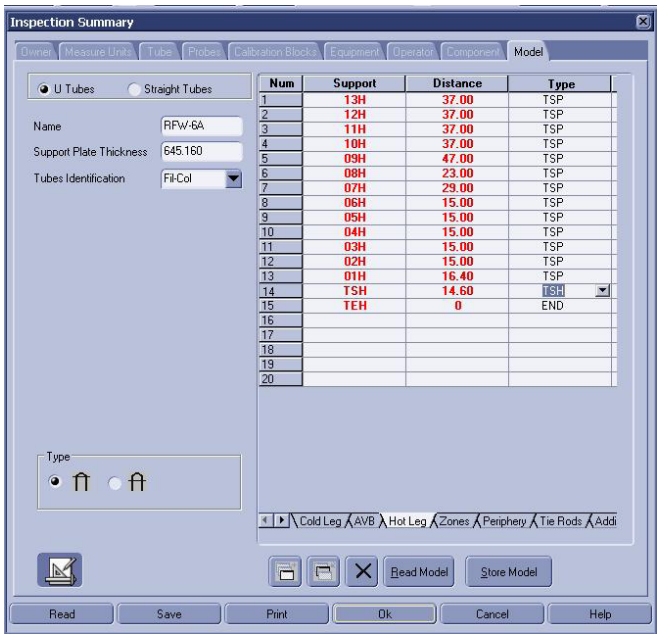


Figure 38 Hot Leg

Hot Leg — Consists of five fields,

Zone, **Support, Distance, Type** and **Thickness.**

Used for describing the characteristics of the structures corresponding to the Hot Leg of the steam generator.

The first two, Support and Distance are compulsory for its self recognition.

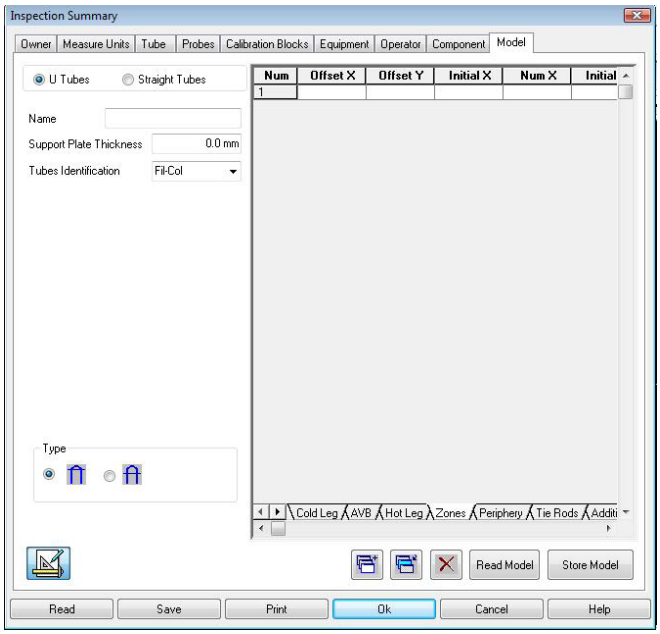


Figure 39 Zones

Zones — Characteristics of each zone are defined here. The fields are:

Offset X — Distance (in number of tubes) between reference tube of zone and origin for axis x
Offset Y — Same as axis y
X initial — Number of reference tube.
Num X — Number of tubes that there are in this zone in axis x
Y initial — Same as axis y
Num Y — Same as axis y
Way X — Increasing or decreasing way of the coordinates for axis x
Way Y — Same as axis y

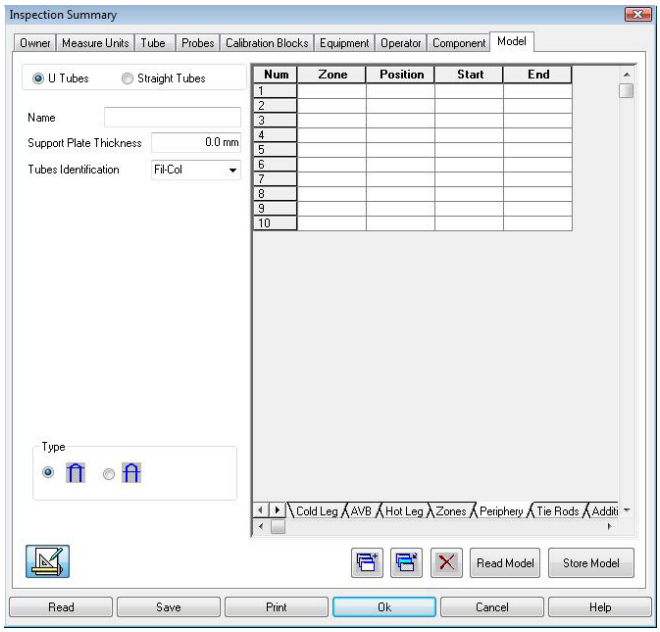


Figure 40 Peripherals

Peripherals —Consists of four fields:

Zones, Position, Start and End.

Position means the row or column according to the type of identification of tubes is chosen.

Fill-Col or Col-Fill) and **Start** and **End**, the initial and final column (or row) that exists for that row (or column).

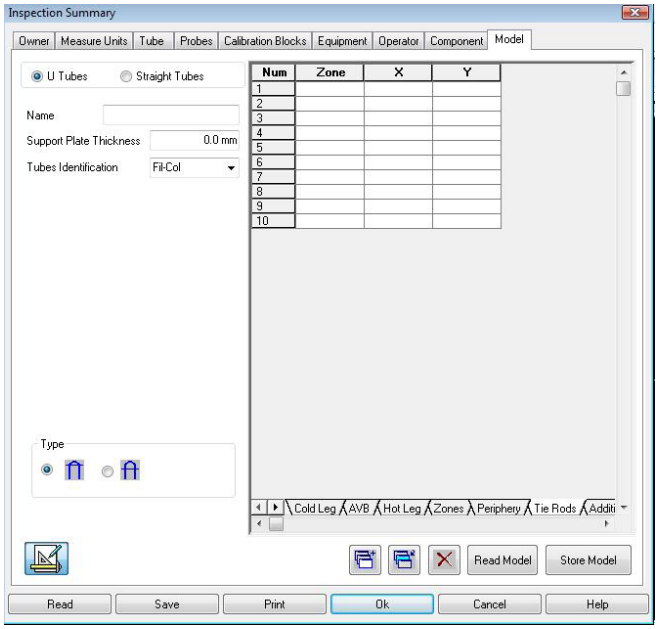


Figure 41 Tie Rod

Tie Rods— Identifies the places where there are component reinforcement columns instead of normal tubes.

Each tube is identified by a zone, row and column.

Additional Data — This window is variable according to the chosen model type and can indicate a series of parameters which are necessary to calculate the distances between those support structures (that are variable depending the tube situation).

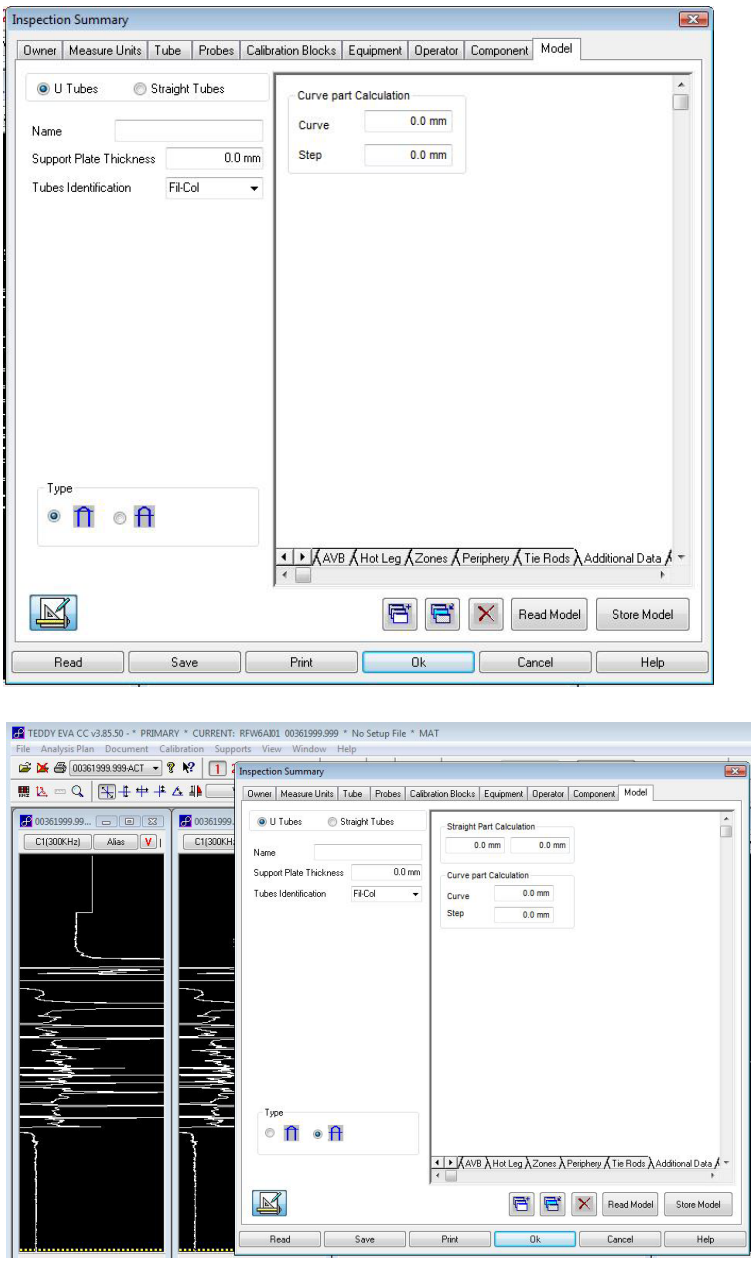


Figure 42 Additional Data

3. **Edit Buttons**

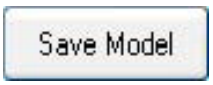
Five buttons appear in order to edit the tables.
These buttons are:

 Inserts a record at the end of the table.

 Inserts a record at the cursor position.

 Deletes the record in which the cursor is located.

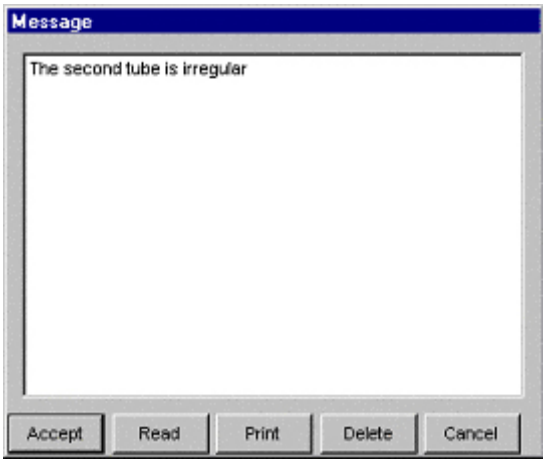
Reads a model from a file.



Saves a model to a file

Inspection Summary 6

6.1 Global Messages



The operator enters information in this window during the acquisition phase so that it can later be read by the analyst. Each message is saved in a file in the same directory as the files containing the acquisition data.

The window has an editing area which is where the user enters the information to be read by the analyst:

Figure 43 Global Message

Accept — A file manager opens to save the message.

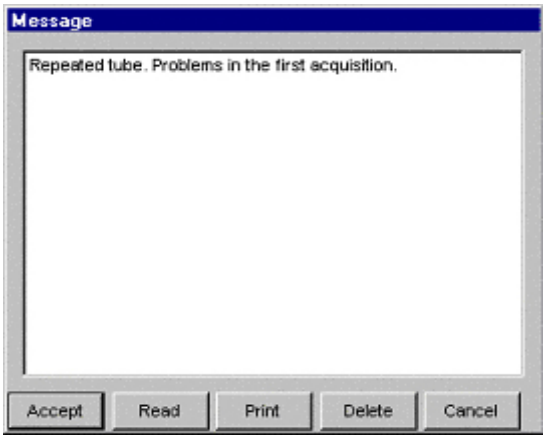
Read — A file manager opens to show the information of a specific message.

Print — Prints the message displayed in the window.

Delete — Clears the editing area so a new message can be written.

Cancel — Ignores the message introduced; the message is not saved and the window closes.

6.2 Associated Messages



The objective of this window is to attach specific information pertaining to a test such as: plugged tube, restricted, etc.

Messages associated with each tube are written during acquisition. In the analysis phase, if the data has an associated message, the user is shown the message when the data file is opened

From the user interface standpoint, the window for messages associated with a test is the same as the global messages window and can be seen in the following figure.

There are two editing areas where the user introduces information.

Accept — The information introduced is validated and saved in the same file with the rest of the data acquired.

Read— Button with no function.

Print— Prints the message displayed in the window.

Delete — Clears the editing area, so that another message can be written.

Cancel— Ignores the message introduced; the message is not saved and the window closes.

6.3 Channels and Mixes

This window displays the information on the different Eddy Current channels together with the different mixes created by the user.

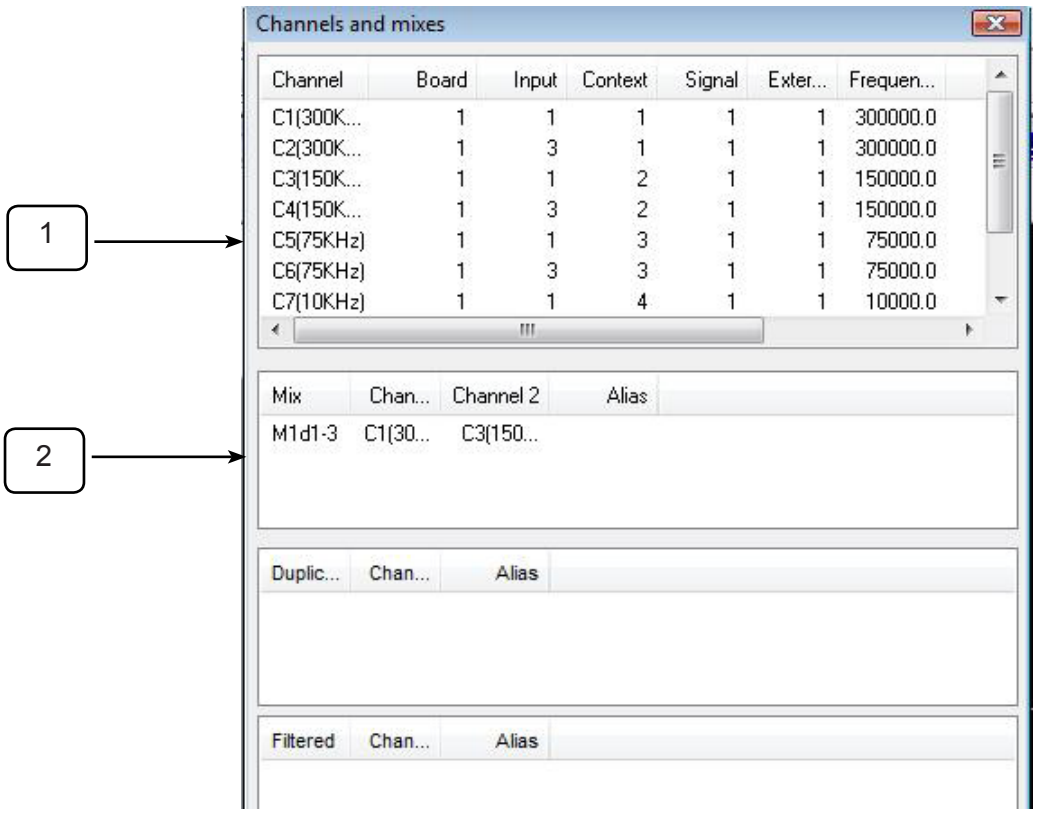


Figure 45 Channel and Mixes

1. **Channels** — This area shows the information relative to the different channels.

   Input — Shows the input information relative to the different channel.

   Context —The interval of time in which the channel is acquired.

   Frequency — Inspection frequency of the channel.

   Gain — Amplification gain associated with the channel.

   Voltage — Excitation voltage associated with the channel.

2. **Mixes** — The information corresponding to the mixes is shown in this area.

   Mix — Identification of the channel. The label associated with the mix is shown.

   Channel1 — Reference to the first channel in the mix calculation.

   Channel2 — Reference to the second channel in the mix calculation.

Analysis and Supervision 7

7.1 Introducton

Data Analysis and Supervision analysis are the main components of this application.

Supervision analysis is the process by which a lead or resolution analyst may review indications reported by the production analyst, permitting the lead analyst the ability to validate final reports, indications, modify the original analysts calls, or enter a new indication as required.

The analysis application operates by the means of a database containing information on the analyzed tubes and the results for each analysis. When analysis is conducted in the **coordinated mode**, the database is shared by all the analysis and acquisition systems as part of a fully networked system, when in the **non-coordinated** mode, the database contains only the information generated for the calibration group that is being analyzed by each specific analysis station.

The visual configuration of the screens (position, size, visibility of fields,...) may be saved for future use as part of the setup, using the option Save setup or Save setup as on the Analysis Plan menu.

A series of utilities, described below, are used for both analysis and supervision analysis. To perform types of analysis the user has the ability to determine if the analysis will be with or without historical data results.

7.2 Analysis Plan Dialog

This window appears by selecting Analysis Plan>New Analysis Plan in the main menu, upon startup of the application.

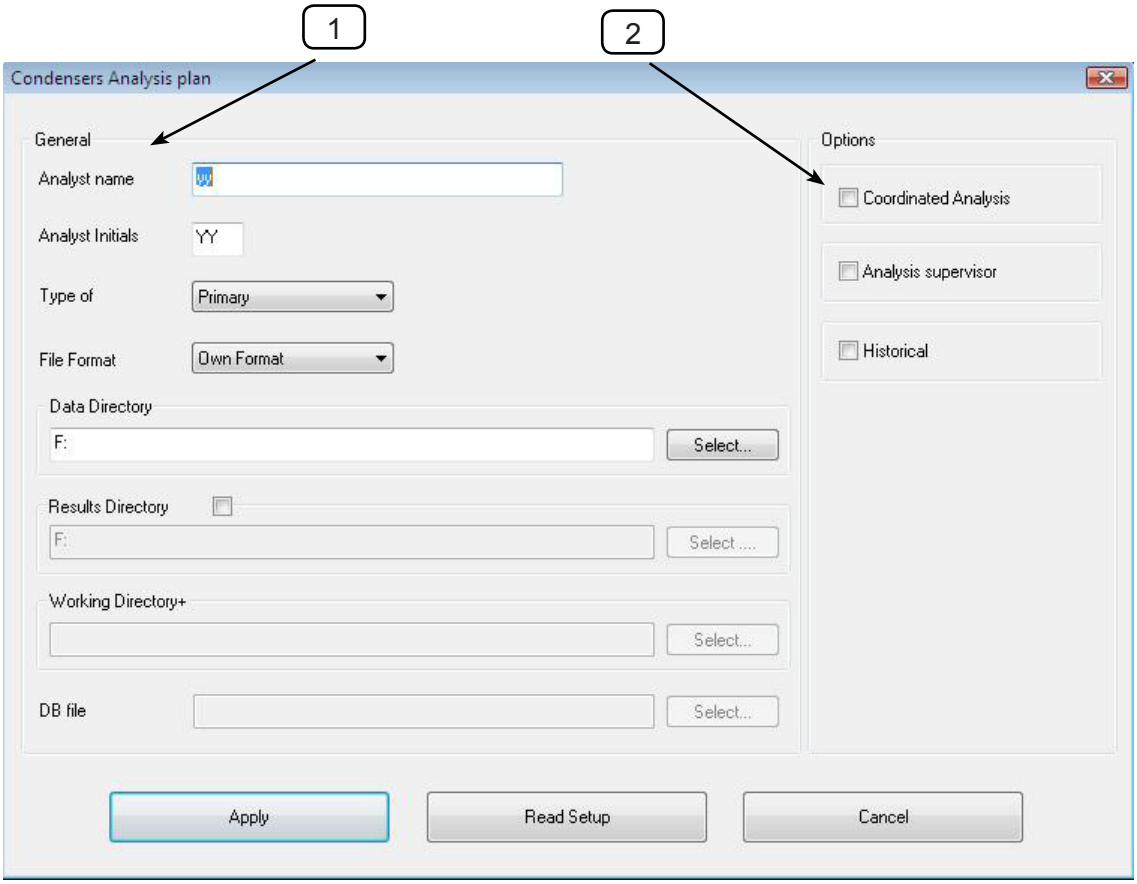


Figure 46 Analysis Plan

1. **General**:

Name of Analyst

Initials of Analyst — Three letters must be entered.

Type of Analysis — Primary, Secondary, Tertiary.

File Format — Own (Apollo) Format, or Miz 18 Format.

Data Directory — Location Analysis results are to be stored.

Working Directory (Historical) — Location containing the previous inspection raw data files.

Historical DB File — Location containing the database file with all results bompiled from Data Management program. (SIRIO)

2. **Options**

Coordinated Analysis — If this option is activated, the database selected in DB file will be used. If deactivated, a local database is generated, located in the analysis directory of the selected calibration group. This mode is not used any more and will be removed from future revisions

Analysis Supervisor — This selects the operating mode for the Supervision analyst.

Historical — If this option is selected, the historical records obtained from the database queries will be searched for in the Historical device + Historical Directory selected by the analyst.

7.3 Calibration Selection Dialog

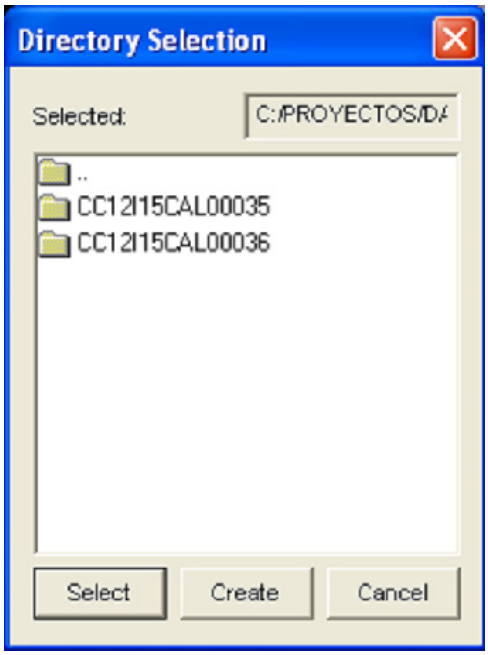


Figure 47 Calibration Group Selection

This dialog is shown when a new analysis plan is generated through the previous dialog or when the **Calibration Group Selection** option is selected on the **Analysis Plan** menu.

To select a calibration group the user must select the cal group by single clicking on the cal name, and press the **Select** button.

7.4 Indications Table Dialog

Based on plant history, types of damage mechanisms may already have been identified. It is common practice to establish three-letter Codes for each of the different type of known damages, as well as rules for their evaluation.

This information is incorporated into the system through the “Indications List”.

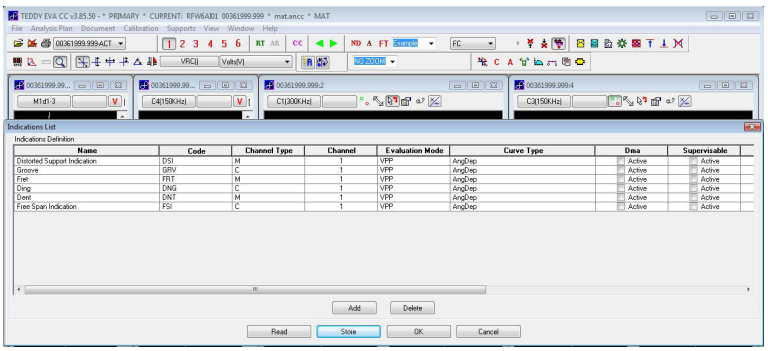


Figure 48 Indications List

The application uses this information, so that the user may select the **type of defect** on the **Toolbar Reporter**, which will result in the signal automatically being measured using the parameters defined in the indications table, and incorporated in the final report.

7.5 Tube Index

The **Tube List** shows the tubes belonging to the selected calibration group when the **Tube List** option is selected on the **Analysis Plan** menu or when the user clicks on the **Apply** button in the **Analysis Plan** dialog.

All the tubes corresponding to the calibration group are shown in the analysis mode. In the supervision mode, only those tubes considered to be reviewable are displayed, in accordance with the definition included on the indications table.

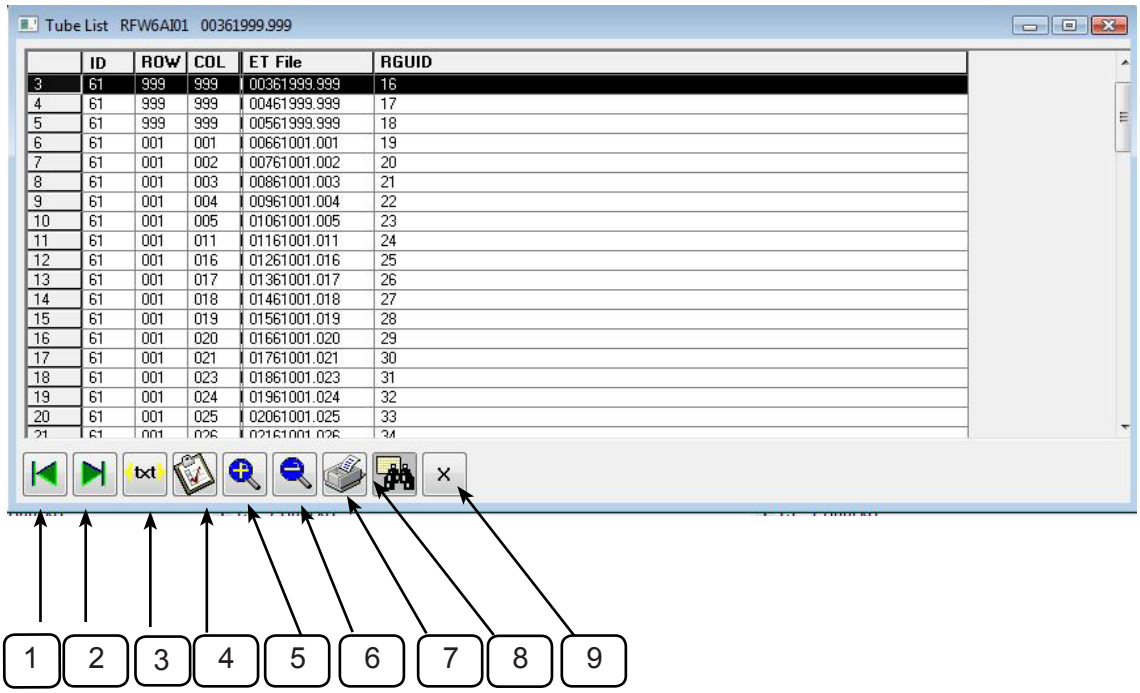


Figure 49 Index of Records

The following actions may be performed in this dialog:

1. **Previous Tube** — When the user clicks with the mouse on this button, the tube previous to the one currently chosen is selected. If it is the first on the list, there is no change (non-circular selection).
2. **Next Tube** — When the user clicks with the mouse on this button, the record following the one currently chosen is selected. If it is the last on the list, there is no change (non-circular selection).
3. **Text** — Expands or contracts viewable fields in Tube List.
4. **View Fields** — Shows the dialog Component Fields List, for customization of the visible index fields.

5. **Zoom +** — Increases the size of the dialog lettering.
6. **Zoom** - — Decreases the size of the dialog lettering.
7. **Print** — Prints the contents of the index. Only active fields are included in the print.
8. **Search** — Opens a dialog window for going to a certain row and column
9. **Close** — Closes the window.

7.6 Current Tube Analysis Results

In the analysis mode the **Results analysis** dialogs show all the indications reported by the analyst for the current tube.

The following actions may be performed on this dialog:

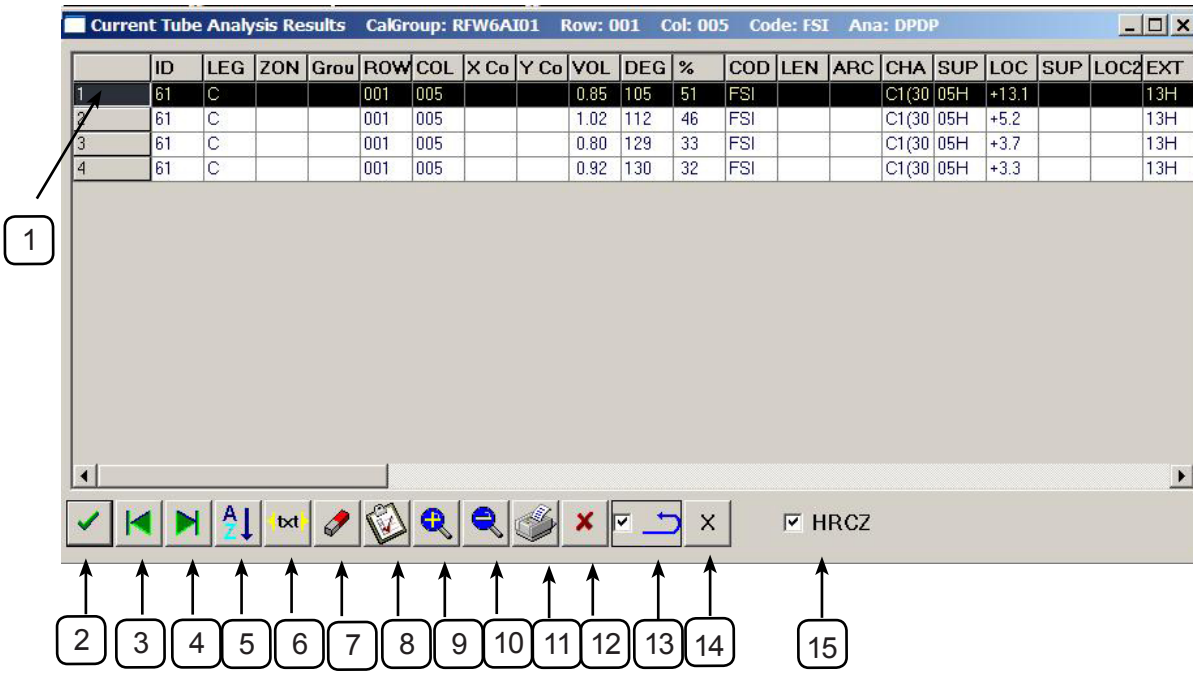
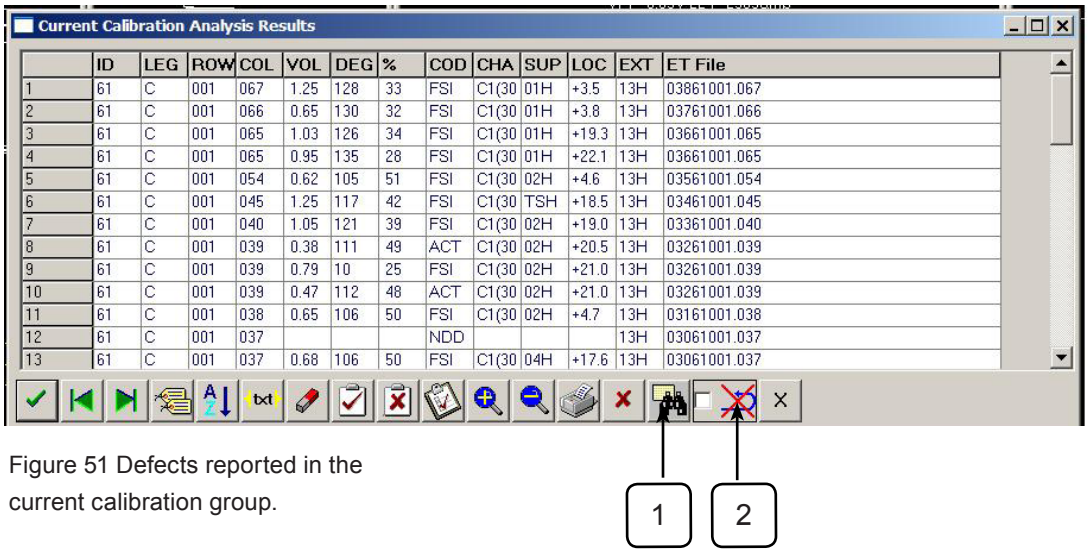


Figure 50 Analysis of Results

1. **Selection of a record** — When the user clicks with the mouse on the indications in question, the record corresponding to this area is marked as active. If the tube corresponding to the result is not active, it is activated. In addition, all the parameters defining the defect, position, measuring modes, opening of expanded strip chart window, ... are updated on the user interface, such that the analyst can see exactly how the indication has been previously reported.

2. **OK** — The user may make changes to some of the record fields or eliminate some using the Delete function. In order for these modifications to have an effect on the database, it is necessary click on this button.
3. **Previous Record** — When the user selects this with the mouse, the record previous to the one currently chosen is selected. If it is the first on the list, there is no change (non-circular selection).
4. **Next Record** — When the user selects this with the mouse, the record following the one currently chosen is selected. If it is the last on the list, there is no change (non-circular selection).
5. **Sort** — When the user clicks on this button, a menu appears allowing for selection of whether the ordering is to be accomplished by row and column or by date.
6. **Text** — Expands or contracts viewable fields in Current Tube Results.
7. **Delete** — When the user clicks on this button, the currently selected record will be deleted, a gap in the remaining numbers will be displayed to reflect this status. For the change to be effective, the OK button must be used.
8. **View Fields** — Shows the Component Fields List, for customization of the visible report fields.
9. **Zoom +** — Increases the size of the dialog lettering.
10. **Zoom -** — Decreases the size of the dialog lettering.
11. **Print** — Prints the contents of the report. Only active fields are included in the printed copy.
12. **Cancel** — If changes have been made to the contents of any field for any record, or in the deletion of any record, this button will result in the report for that indication reverting back to its original status.
13. **Read Selected Tubes** — Locks and unlocks recall flaw from report.
14. **Close** — Closes this window.
15. **Copy Defects of Current Zone** — This option is used when there is historical information when working with U-bend tubes. The tubes can be divided into zones and the acquisition process carried out by zones, permitting several data files for a particular tube (one file per zone). If this option is selected only the historical defects reported in the zone of the current tube will be displayed, otherwise all the defects, regardless of zone will be displayed.

Once all the defects for a given tube have been entered into the current tube window the user validates the entry and reads another tube into the analysis window. When the defects are validated they become part of the final report of the calibration group. The current tube analysis window displays only those entries for the tube currently being analyzed, selecting the enter button in this window will place the analysis information in the calibration group final report.



	ID	LEG	ROW	COL	VOL	DEG	%	COD	CHA	SUP	LOC	EXT	ET File
1	61	C	001	067	1.25	128	33	FSI	C1(30	01H	+3.5	13H	03861001.067
2	61	C	001	066	0.65	130	32	FSI	C1(30	01H	+3.8	13H	03761001.066
3	61	C	001	065	1.03	126	34	FSI	C1(30	01H	+19.3	13H	03661001.065
4	61	C	001	065	0.95	135	28	FSI	C1(30	01H	+22.1	13H	03661001.065
5	61	C	001	054	0.62	105	51	FSI	C1(30	02H	+4.6	13H	03561001.054
6	61	C	001	045	1.25	117	42	FSI	C1(30	TSH	+18.5	13H	03461001.045
7	61	C	001	040	1.05	121	39	FSI	C1(30	02H	+19.0	13H	03361001.040
8	61	C	001	039	0.38	111	49	ACT	C1(30	02H	+20.5	13H	03261001.039
9	61	C	001	039	0.79	10	25	FSI	C1(30	02H	+21.0	13H	03261001.039
10	61	C	001	039	0.47	112	48	ACT	C1(30	02H	+21.0	13H	03261001.039
11	61	C	001	038	0.65	106	50	FSI	C1(30	02H	+4.7	13H	03161001.038
12	61	C	001	037				NDD				13H	03061001.037
13	61	C	001	037	0.68	106	50	FSI	C1(30	04H	+17.6	13H	03061001.037

Figure 51 Defects reported in the current calibration group.

The functionality of this window is similar to that of the “current tube results window”, with the exception of two additional buttons

1. **Find** — Opens a window permitting the analyst to search for a defect from a tube by specifying row-column values.
2. **Read Selected Tubes** — If this button is activated, when selecting a tube from the report, the entry will be recalled and the indication displayed on the screen as it was entered by the analyst.

7.7 Results in Supervision Mode

In the **Supervisor** working mode, after selecting the calibration group to analyze, a filter window will be shown to select which defects must be reviewed. From all the defects reported it is possible that the supervisor is only interested in some of them. To select these defects of interest we can apply several criteria:

Voltage Range — The user can specify a range of voltages [min, max] in such a way that all the defects with a voltage value inside this range will be displayed for review.

Thickness Loss — If the supervisor establishes a thickness loss range [min, max], all the defects with a loss of thickness value inside this range will be displayed for review.

Defect Status — The status of a defect refers to the way it was created. There are three possible states: new (N), historical (H) and modified (M). A new defect is one created by the analyst. A historical defect is one created copying it from a previous historical one without modifying it. A modified defect is one copied from a historical one but that has been modified. If, for

instance, the supervisor selects the new and the historical defects, all of them will be reviewed.

Type of Defect — There is a list of defects that the supervisor can update. For each defect the user can establish if it can be reviewed or not. All the defects that can be reviewed will pass the filter. All the defects not on the list will pass it as well and required resolution by the lead analyst. There are two special cases: NDDs will never pass the filter and RETESTs will always pass through for additional review.

It is important to remark that the condition on which a defect will be considered reviewable is that it fulfills one or more of the previous criteria. For example, if the voltage value of the defect is not inside the range established but its thickness loss is inside the range, the defect will pass the filter.

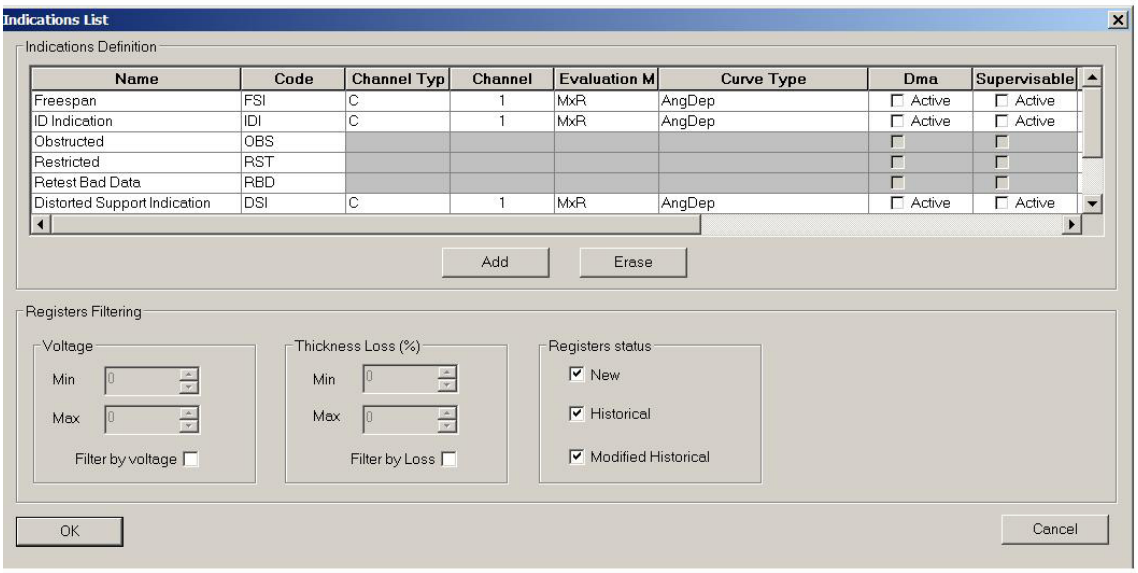


Figure 52 Supervision Filter

The working method is different in supervision mode. Instead of analyzing tube by tube, the supervisor analysis is defect by defect using the list of recorded defects from the calibration group. When a defect is selected, the Tube index automatically selects the tubes with defects and the list of defects for that tube is updated. Once the supervisor has selected the defect, it must be checked. If the supervisor considers that it is valid, the defect is validated and the next defect on the list is read. If not, the defect can be modified or cancelled. If it is cancelled, the defect is marked as cancelled but not eliminated from the database. In addition to be able to resolve indications from the original analysis, the supervisor can add new defects. Once all the defects have been supervised, the calibration group should be closed.
The window with the list of defects of the calibration has two additional buttons.

Figure 53 Validate and Cancel buttons

Validate Record, allows the supervisor to accept the information of the reported defect as being correct, marking the **supervised** field of the record and moving the selection on to the next record.

The second of these buttons, *Cancel Record*, allows the supervisor to reject the indication reported as being incorrect, marking the **cancelled** and **supervised** fields of the record and moving the selection on to the next record.

7.8 Historical Report

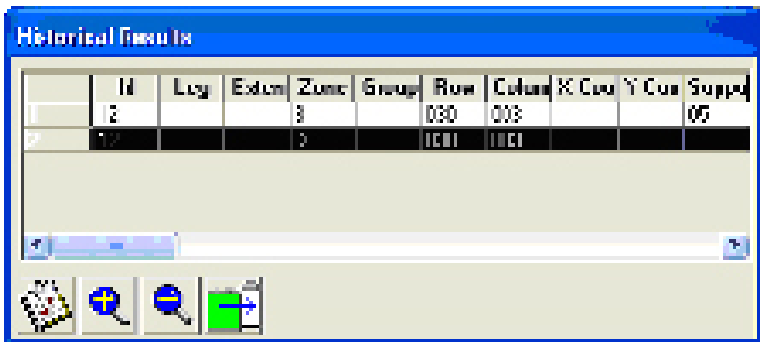


Figure 54 Historial Results

The Historical results dialog shows the information reported in previous inspections for the tube currently being analyzed. In order for this dialog to show the appropriate information, the historic option of the Analysis Plan must be selected, and the database must have been prepared with the historical information of interest. When a tube is selected in the Tube index, the historical indications are copied to the Historical results dialog and to the list of indications of the current tube. The figure below corresponds to the Historical Results dialog. It has four buttons. From left to right their functions are: select the visible fields, zoom in, zoom out and copy defects to the list of defects of the current tube.

If, in addition, the analysis plan dialog includes the specification of the path where the records for tubes belonging to the previous inspection are, the application will show the two tubes simultaneously in different colors, as shown below:

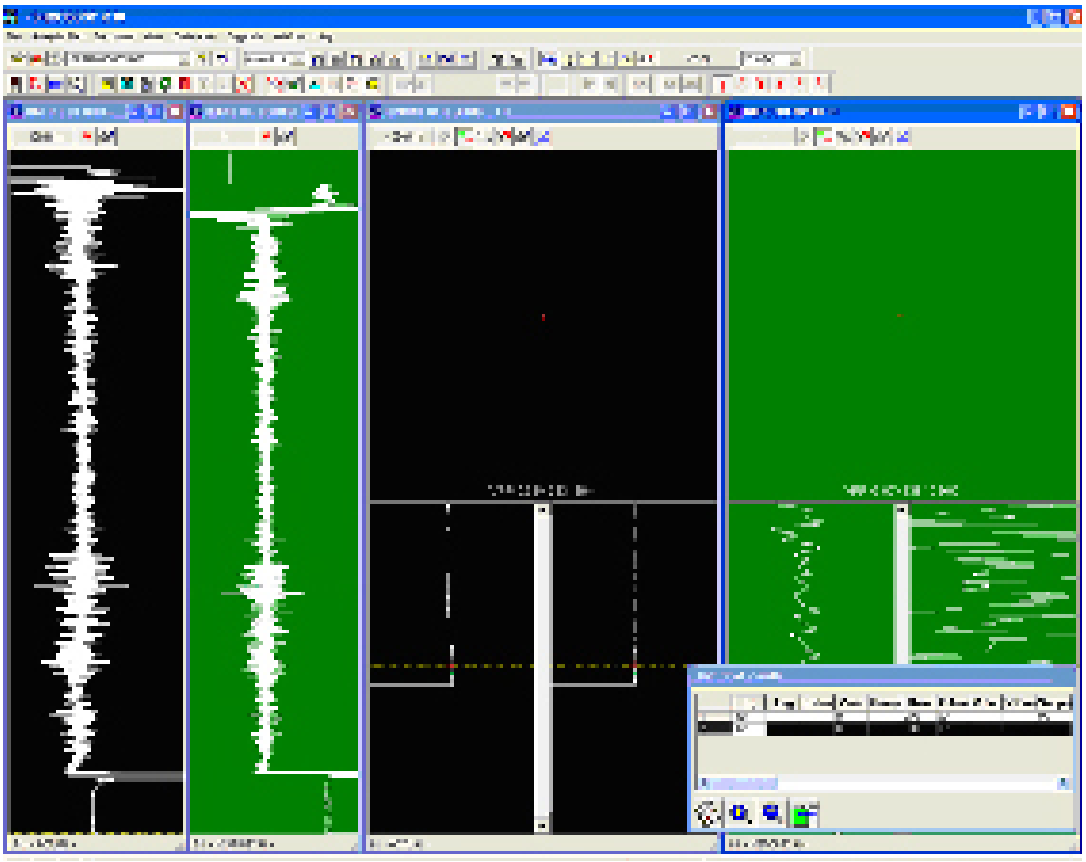


Figure 55 Current andHistorical tube

When working with U-bend tubes, there is an additional dialog that shows the historical tubes corresponding to the current tube. This is because for U tubes the acquisition of a single tube can be divided into several zones, obtaining a file per zone. Therefore, a tube can have several files associated. So, by means of this dialog the user can see the historical files associated to the current tube regardless of zone.

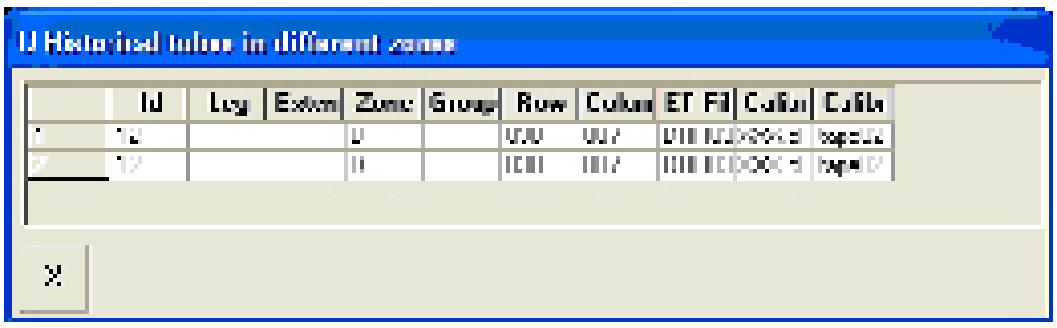


Figure 56 Historical indications of the current tube.

7.9 Validation Dialogs

Whenever information is to be added to the database, through the **Reporting** toolbar, the corresponding validation dialogs are shown, in which the analyst may change certain parameters, validate or cancel them.

The **Validation Retest** dialog is used for Retest indications, Button **RT**.

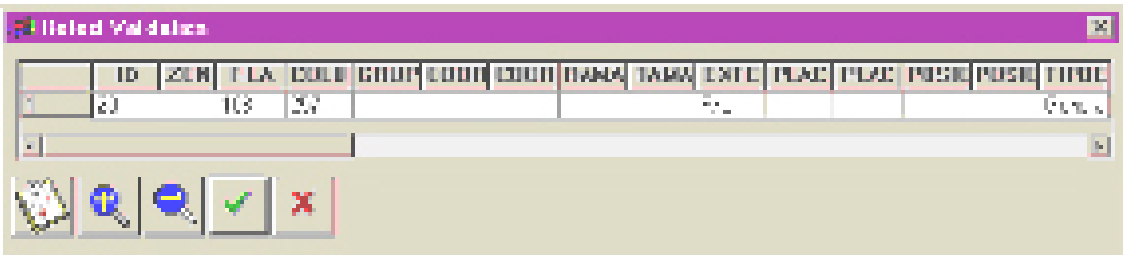


Figure 57 Validation of Retest

For defect indications the Validation Indication dialog is used.

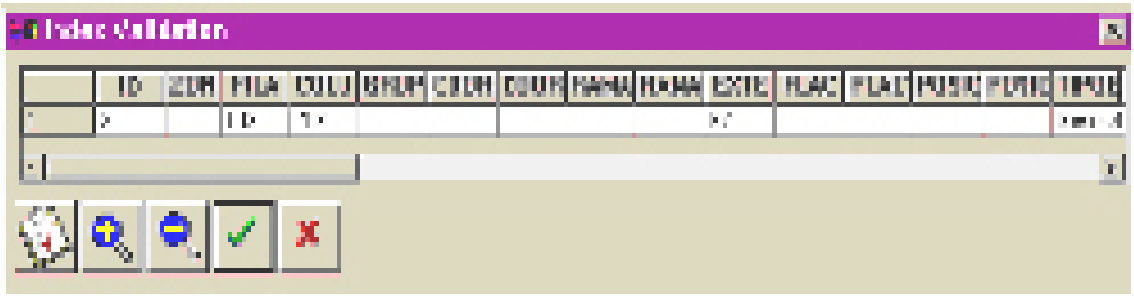


Figure 58 Validation of Indication

7.10 Component Fields List

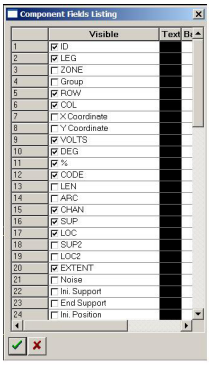


Figure 59 Component Fields List

For all database dialogs, the user has the ability to edit which fields will be displayed as part of the final report format.

Calibration Controls 8

8.1 Calibration Control

This window will be available whenever a data file is open.

The calibration control consists of eight pages labeled with the following titles: Calibration, Channels, Automatic, Mixes, Curves, Coordinates, Duplicated and Filter. The aim of the calibration control is to carry out all the processes involved in the calibration. Each page is described below.

On this page the different channels and mixes are calibrated in phase, amplitude and voltage.

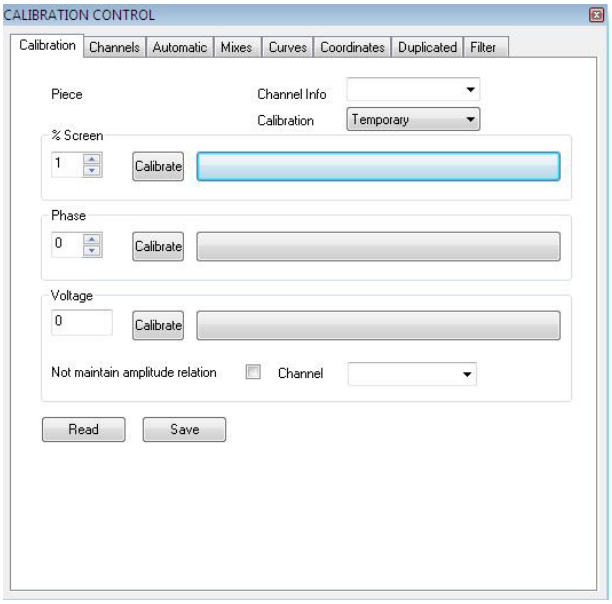


Figure 60 Calibration

Piece. Area of information which indicates the calibration standard corresponding to the calibration being carried out.

% Window Size. Amplitude of the signal displayed in the Lissajous with regards to the percentage of the window it takes up. The value will be between 1% and 100%. The value will be increased or decreased using the arrows. The numerical information which appears on the right informs the user of the amplitude value in absolute mode.

Phase. Angle of rotation of the signal is displayed in the Lissajous. The phase varies between 0 and 360 degrees. The arrows are used to increase or decrease the value. The numerical information which appears on the right corresponds to the angle by which the signal is to be rotated for the specified phase.

Voltage. By introducing a voltage value and clicking on button (s) Current or All, the voltage is associated from the peak to the maximum peak distance of the signal in the Lissajous (where the area for measuring the peak to peak value is given by the window which is defined by the position of the cursor). When the option ***Don't maintain amplitude ratio*** is toggled on and the ***All*** button is selected, each channel is calibrated in volts independently. If this option is toggled off the calibration in volts is done for the active channel only.
These three options include the following three buttons:

Current — If this button is selected the calibration in phase or amplitude of the signal is carried out for the specified channel.

All — If this is button is selected the calibration in phase or amplitude of the signal is carried out for all the channels and mixes defined.

Df/Ab — If this button is selected the calibration in phase or amplitude of the signal is carried out for all the channels and mixes of that type, (Absolute or Differential). The signal is modified according to the percentage of the screen specified in all the same channels. It rotates so that the channels have the same phase.

Type — When this button is clicked the different types of channels are displayed: **Absolute or Differential**.

Automatic Calibration — Automatic calibration is based on the execution of a series of calibration operations using reference indications on the standard identified by the user (positions defined by the user in the Lissajous display).

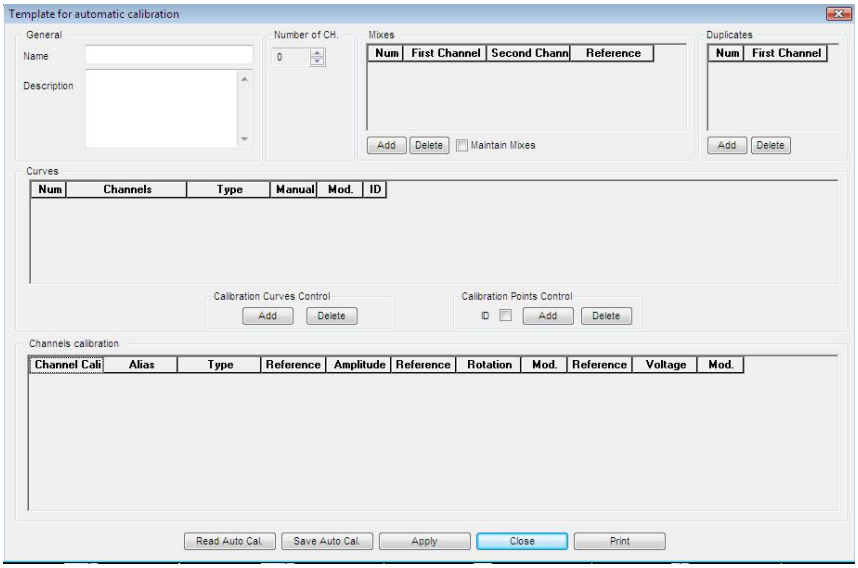


Figure 61 Template for Automatic Calibration

There are 5 different areas in this window:

1. **General** — Permits the user to enter general information for the calibration to be carried out.

   — Name

   — Description
2. **Number of Channels** — This identifies the number of channels being used as part of the set-up
3. **Mixes** — Area is used for creating the mixes to be generated when the automatic calibration is run.
4. **Curves** — Used to define the curves to be generated and the depth values for the curves to be applied to all the channels.
5. **Channels Calibration** — This area is used for establishing the characteristics of amplitude, rotation and voltage for all the channels.
6. **Button Bar** — This is a series of buttons for editing the different automatic calibration files.

   Edit — Displays the Auto-Cal Editor

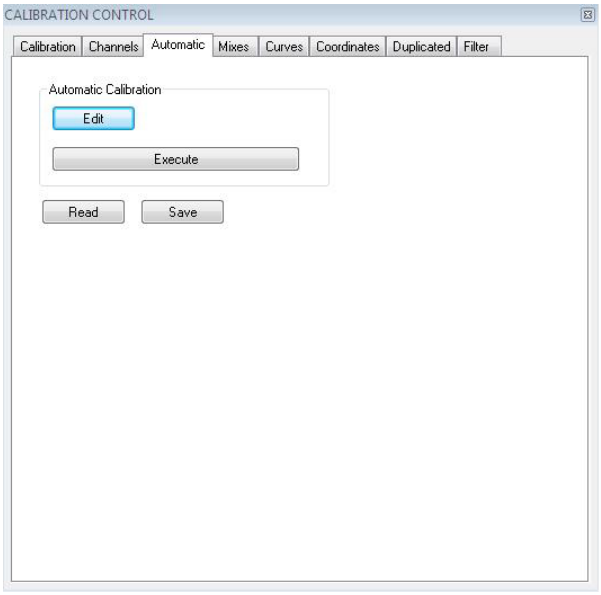
   Execute — This carries out the automatic calibration routine.

   Read — Recalls a stored Auto-Cal configuration.

   Save — Saves an Auto-Cal configuration.

8.2 Mixes

The function of this page is to create and delete mixes between channels. The mixes are done so as to eliminate undesired signals.



Mix — Drop down menu for choosing the mix to be created or deleted, also used for displaying which channels were used for a specific mix.

First Channel — Drop down menu for choosing the first channel to be used with the mix.

Second Channel — Drop down menu for choosing the second channel to be used with the mix.

Figure 62 Mixes

Buttons:

Create — Select this button to create and calculate a mix between the channels specified in Channel1 and Channel2. The signal to be eliminated is displayed in the Lissajous, and within the cursor window.

Delete — Deletes the selected mix.

Recalculate — This button calculates the selected mix. The signal to be eliminated is also displayed in the Lissajous, and within the cursor zone.

Read — Used to load a calibration file.

Save.— Used to store the calibration data in a file.

8.3 Curves

This page is used to define and create the calibration curves for the different channels and mixes.

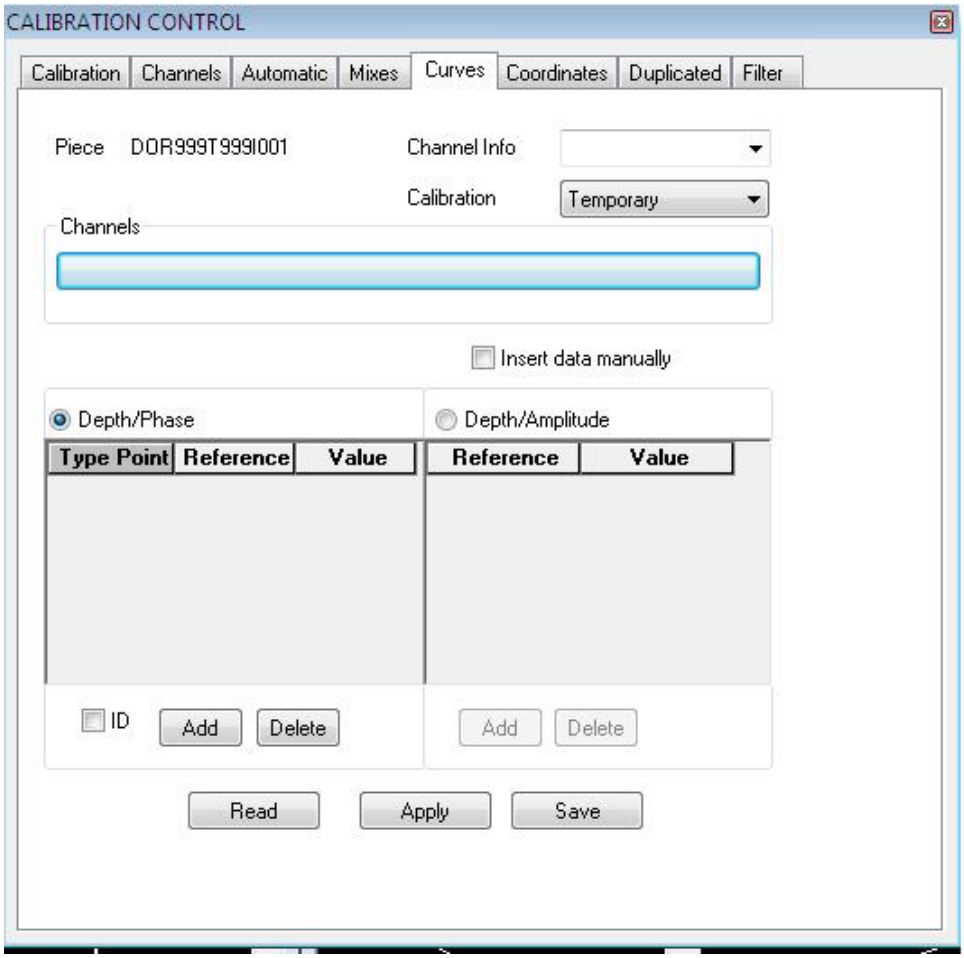


Figure 63 Curves for Tubes

Channel — Drop down menu for choosing the channel or mix for in which the calibration curves will be made.

Piece — Information area which indicates the calibration standard corresponding to the calibration being carried out.

Calibration of Depth with Regard to Phase

Curve Outer(OD) — Depth data.

Calibration of Depth with regard to Amplitude

Values — Depth data.

Current — Click on this button to apply the calibration curve to the specified channel.

All — Click on this button to apply the calibration curve to all the channels and mixes that have been defined.

Read — Used to load a calibration file.

Save — Used to store the calibration data in a file.

8.4 Coordinates

This dialog is used to calibrate the coordinates.

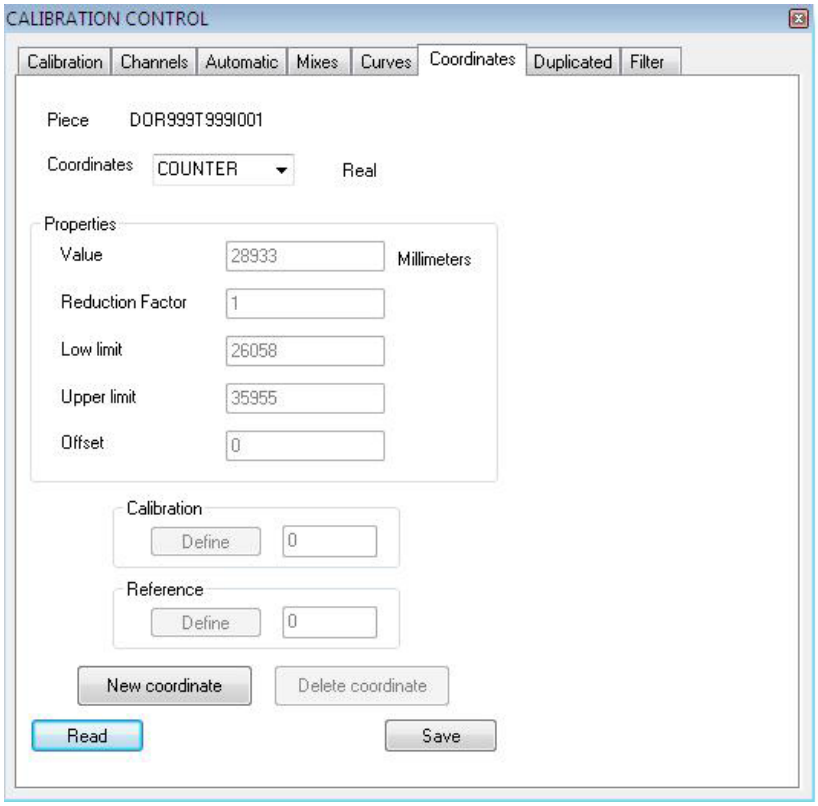


Figure 64 Coordinates

The information in the upper part of the dialog window shows the calibration standard being utilized together with the units and the type.

This window is used to select the coordinate to be calibrated:

The options which will display in the coordinates selection control refer to one of the two Apollo encoders or to a new coordinate defined using the New Coordinate option. The labels will be introduced by the user in the Configuration window. For example:

— AXIAL

— CIRCUMFERENTIAL

Two marks are then placed on the stripchart, defining the distance between both. Then click on *Define* in Calibration.

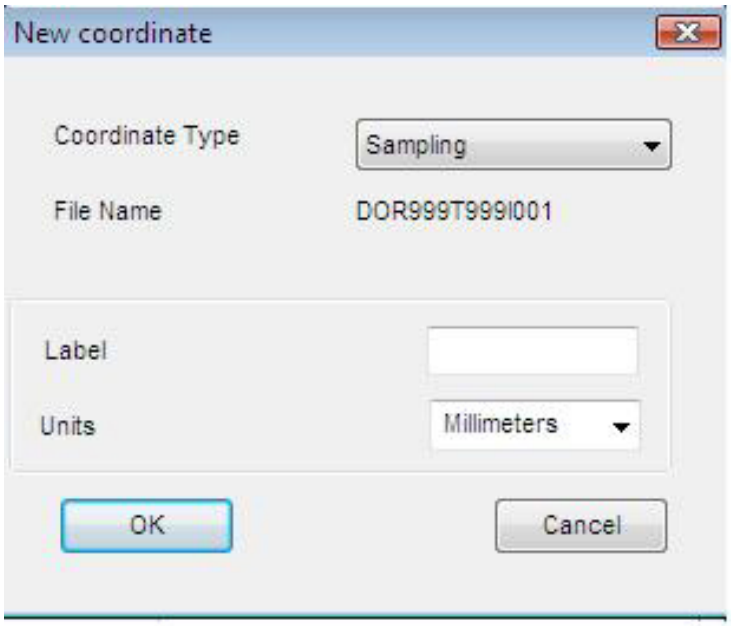
It is possible to indicate what the origin of the calibration will be by introducing a reference value and clicking on *Define*. The origin will take the position of the cursor as its reference.

New Coordinate — This option will display the following window:

The available options are:

Type of Coordinate — The only option available is sampling.

Document — This indicates the file which is being worked on.



Label — Allows a name to be given.

Units — Millimeters or degrees may be selected.

Read — This allows a calibration file to be loaded.

Save — This allows the calibration data to be saved in a file.

Figure 65 New Coordinate

8.5 Duplicate

Select the ‘Add’ button to incorporate a new channel which will be a duplicate of the channel originally selected. This feature is ideal for looking at data with reduced span values for indications such as large voltage dents.

Figure 66 Duplicate

The option delete allows the user to delete a previously created duplicate channel.

Duplicate channels may be displayed in any of the windows capable of displaying raw data. Such a lissaious and strip chart displays.

8.6 Filters

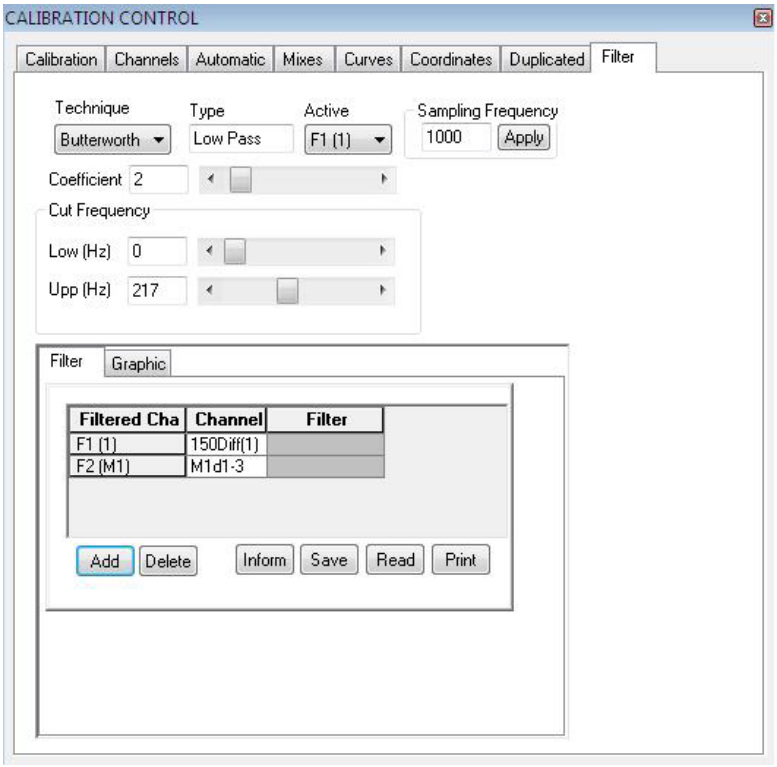
The lower part of this window is subdivided into two sections:

1. **Filter**

   Allows the user to **Create** or **Delete** filtered channels.

   The **Add** and **Delete buttons** allow the user to edit the number of filters associated with a filtered channel.

   The filter parameters can be configured in the upper section of the window. The user can configure the following parameters:



Technique
Butterworth or Chebyshev.

Type
Low-pass, high-pass or band-pass.

Active Channel
One of the filters created.

Sampling Frequency

Coefficient
Indicates the filter order.

Cut Frequency
Lower and upper frequencies of the filter.

Figure 67 Filters

The **Inform Button** displays a window with information related to the filter generated.

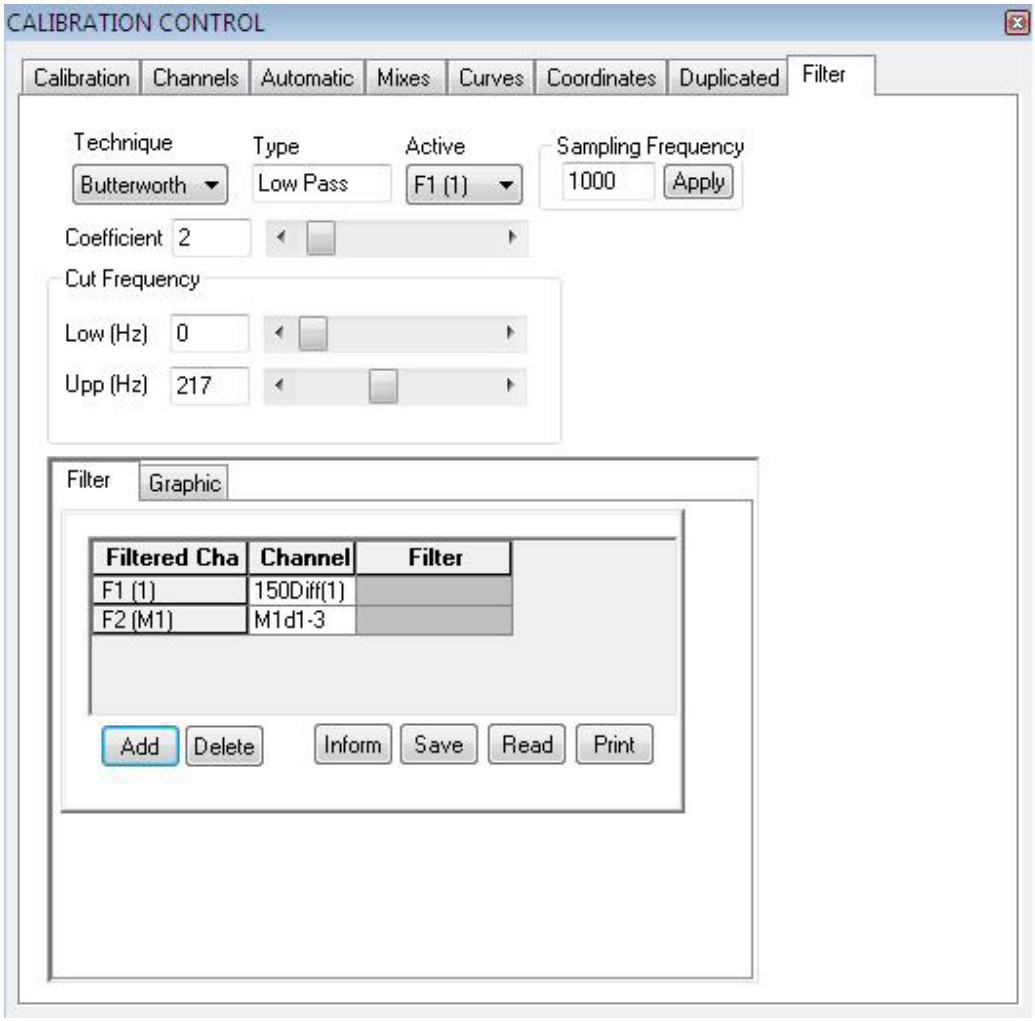
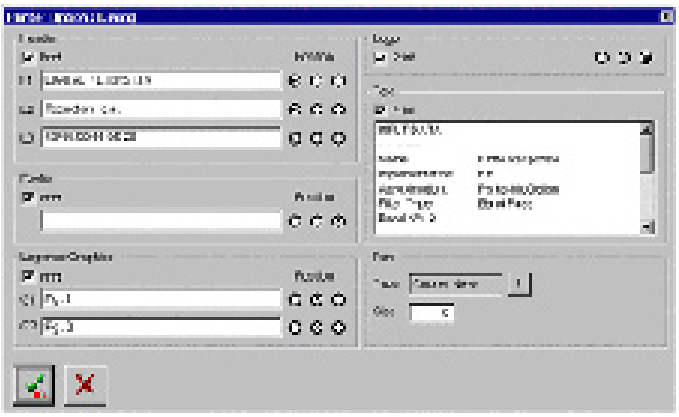


Figure 68 Filter Report



Store saves the filter to a file.

Read is used to retrieve the saved filter information.

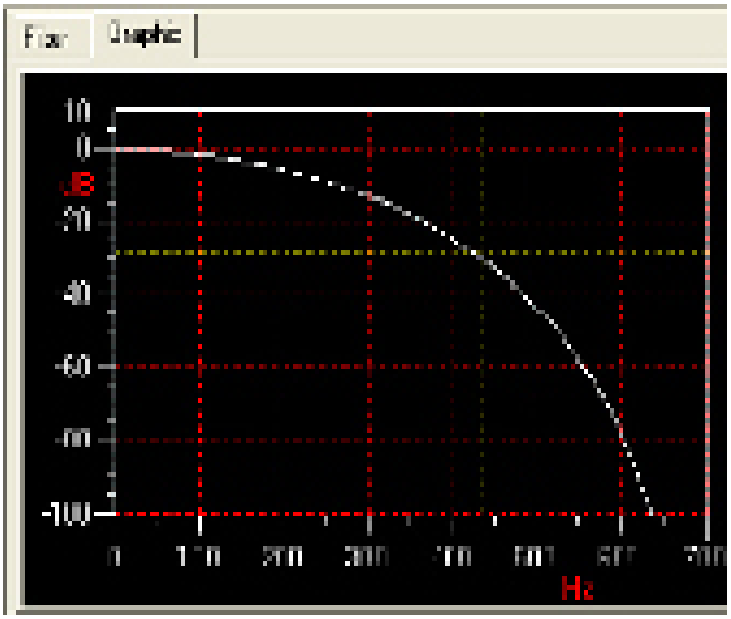
Print generates a printout of the filter information.

The printout can be configured in the following window:

Figure 69 Print Options

2. **Graphic**

This section is used to show the graphical representation of the filters created .



By means of the right mouse button, the user can move the cursor along the curve to obtain the frequency-dB values.

Figure 70 Graphical Representation of a Filter

Representation of Signals 9

9.1 Alphanumeric Window

The data corresponding to both the eddy current channels and a counter or coordinate are given numerically.

There are various different areas in this window.

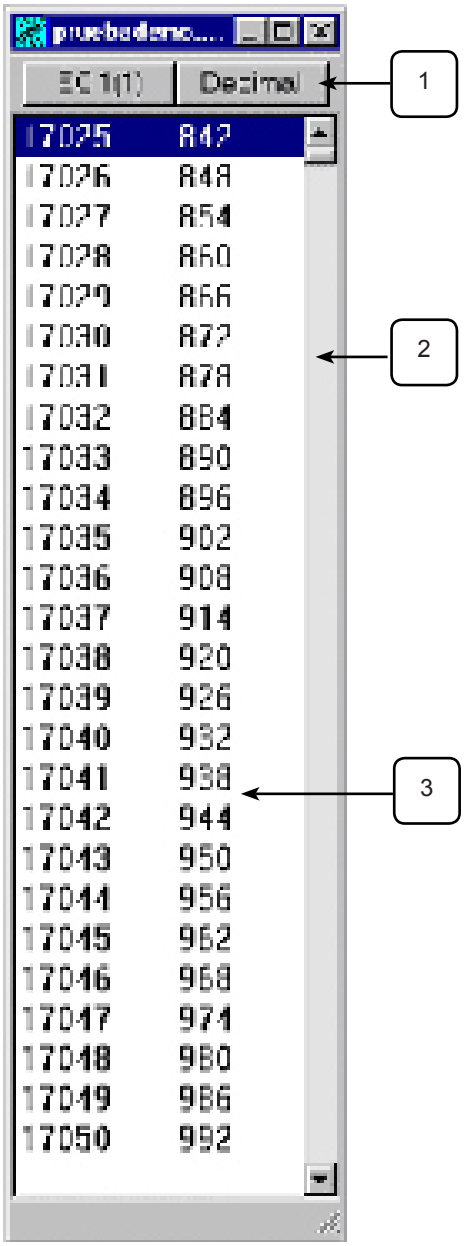


Figure 71 Alphanumeric Window

Button Bar — In this area there are various buttons which carry out the following functions (from left to right):

1. **Change Channel**. Left or right clicking on this button with the mouse will change the channel and display numerical information on the different types of channel (EC channels, counters and encoders).

   Numerical System. Shows a list along the length of the tube, in decimals or hexadecimals.

2. **Scroll Bar** — Left clicking with the mouse on the scroll bar will move the cursor over all the data relative to the tube. The same function will occur by clicking the up and down arrows on the Scroll Bar.

3. **View Area** — This is the area where the numerical value of the acquired data is displayed. If it is a counter or coordinate two columns are displayed: the first column corresponds to the identification of the sample acquired and the second column gives the value of the counter or the coordinate. If it refers to EC channels, three columns are displayed: the first column corresponds to the acquired sample and the following two columns refer to the X and Y components of the channel. The sample where the cursor is to be found is displayed in reverse video.

9.2 Stripchart Window

This window gives a graphic display of the data corresponding to either the horizontal or vertical component of an eddy current channel.

There are various areas in this window.

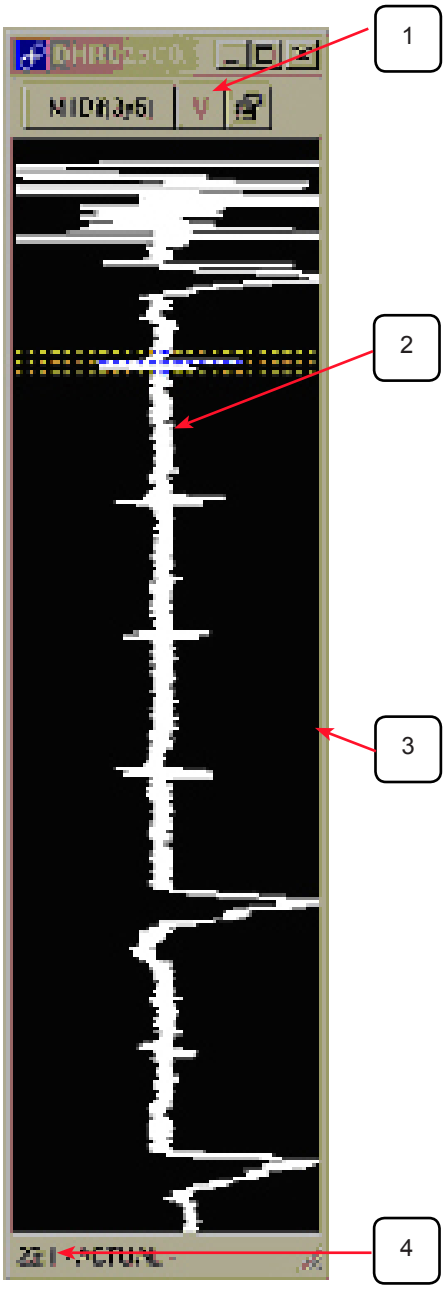


Figure 72 Stripchart Window

1. **Button bar**. In this area there are specific buttons which carry out various functions (from left to right)

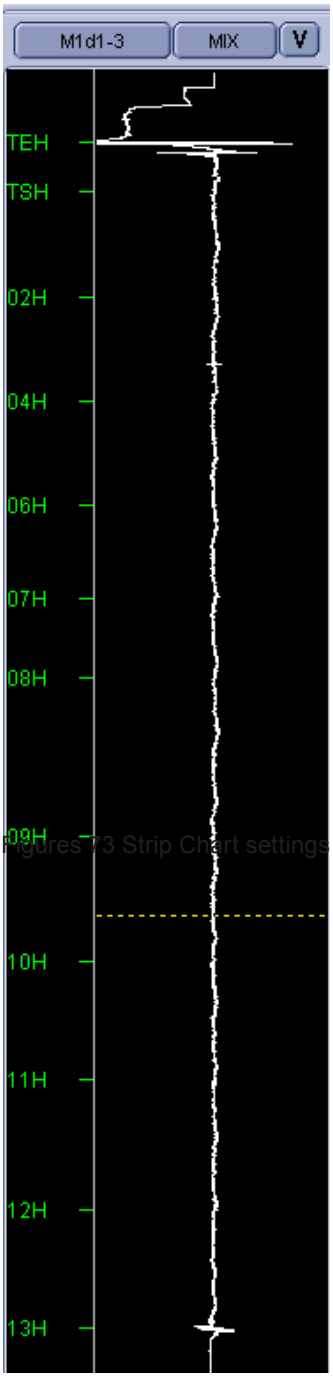
2. **Change Channel** — The first button is for showing the information on the channel being displayed. Left and right clicking with the mouse on this button will display the different EC channels corresponding to a specific piece (tube).

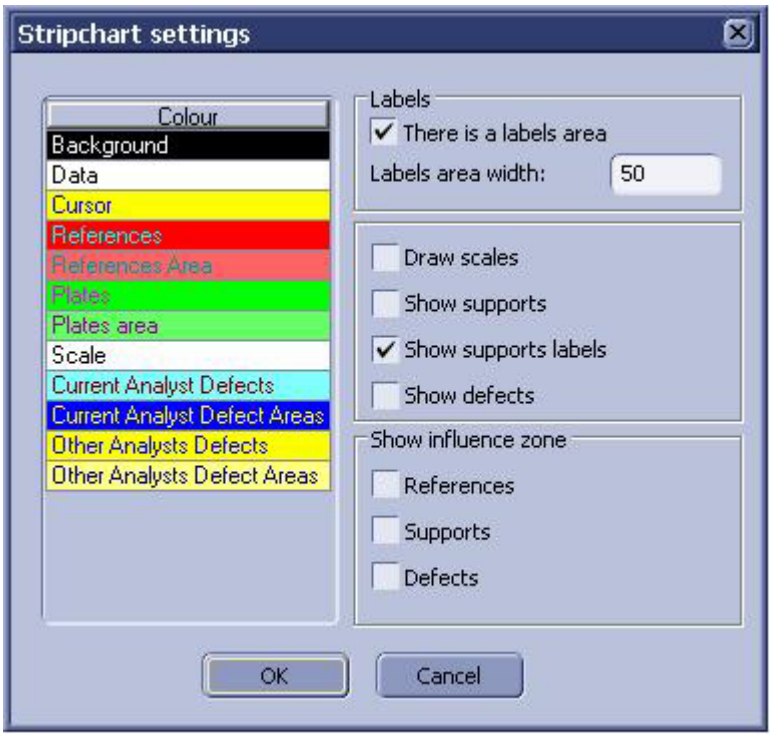
3. **Component Selection** — To choose the horizontal or vertical component to be displayed left click with the mouse on the letters H and V respectively.

4. **Properties** — Opens a window that allows the support labels and the scale of all the record to be shown:

The properties dialog, label zone, defining its width and the axis of the stripchart can be activated. The color of the background, data, cursor, marks, supports and the scale c an be set as well.

If the options are activated, Stripchart will be shown as follows





Figures 73 Strip Chart settings

In this area of the Stripchart, labels will be editable

Delete Support — Pushing the left mouse button on the label will be delete the support structure.

New Support — Places a new support label in the cursor position. Selecting the new support label with the right button will place it in the strip chart window.

Change Label Supports — If in the cursor position there was already a label and the same operation explained above is repeated, the label will be changed to reflect the new support information.

Cursor — This is made up of a yellow horizontal line which defines the current position of the cursor. To move the cursor along the strip, hold down the left button of the mouse and move the cursor in the window.

Scale — On the lower part of the strip the user is informed of the scale of the display. This value indicates the number of samples that will be displayed depending on the zoom.

Below is a description of the functions of the mouse on the area of the strip.

- **Left Button** — Move the cursor to the desired position. Click the button and move the mouse along the strip.
- **Right Button** — Clicking this button compensates (balances) the signal, centring it on the screen in the current position of the cursor.
- **Shift + Left Button** — Clicking both buttons simultaneously adds or deletes a mark at the position of the cursor. This is only operational when a file is being analyzed, it will not work in the acquisition mode. Both keys should be pressed at the desired position to put a mark on the strip. To remove a mark, press both keys over the mark you wish to delete.

9.3 Lissajous Window

The Lissajous window is made up of the signal itself (two-dimensional representation, XY) and an expanded strip chart of the vertical and horizontal component associated with the channel. The quantity of the signal displayed on the Lissajous window is determined by the area of influence or window of the cursor.

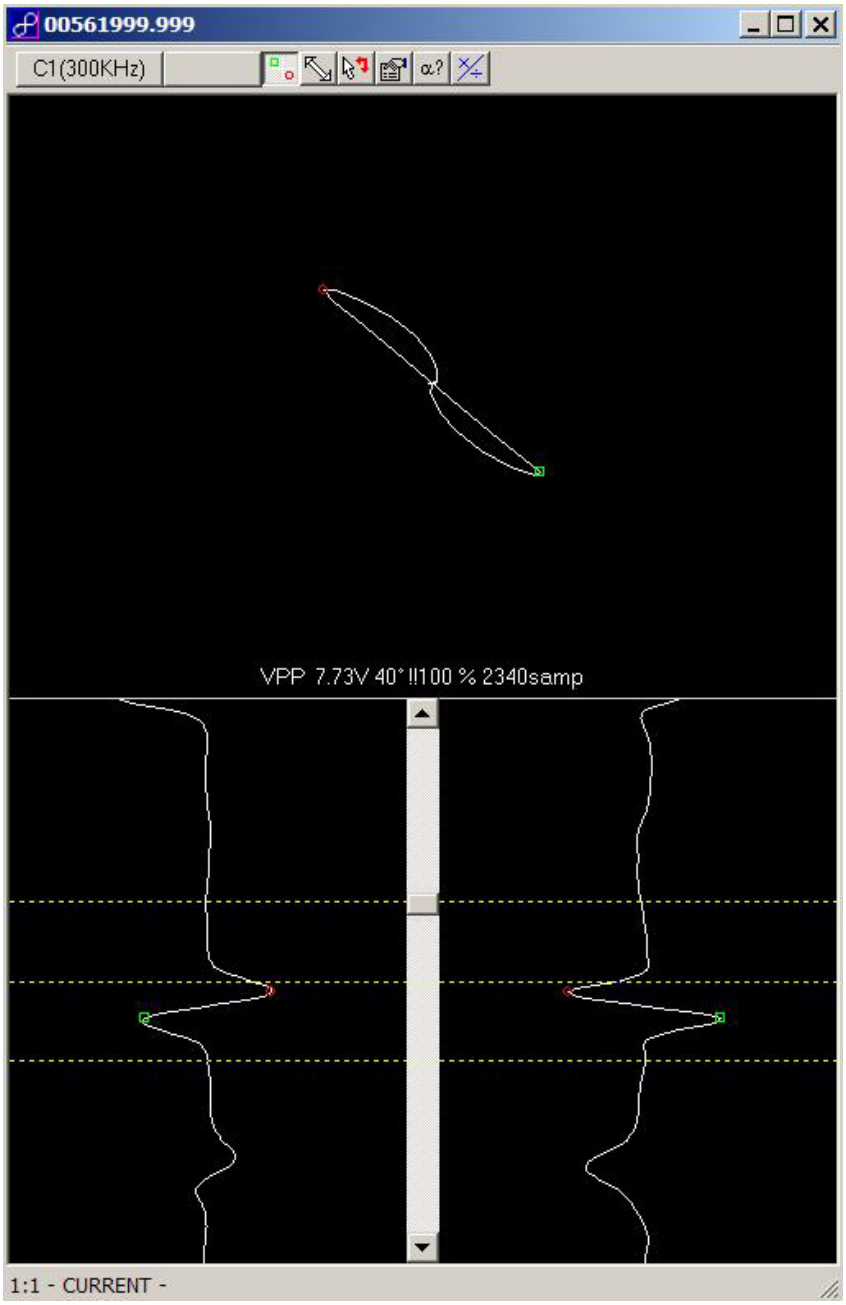


Figure 75 Lissajous Window

Button Bar — There are various buttons in this area which carry out the following functions (from left to right):

Change Channel — Left or right clicking on this button displays the different channels corresponding to the setup used when the data was acquired. Additional, information is given on the frequency of the channel and whether it is an absolute or differential channel.

Evaluation Mode — The measurement classification of the signal which is being displayed is in the lower part of the Lissajous window. These measurements are the volts, phase and depth value corresponding to the active calibration curve. In this mode, it is possible to carry out a specific measurement by placing the Lissajous measurement points on the desired signal using the left button of the mouse.

According to the measurement mode, the evaluation data would be:

VPP, Peak to Peak Volts — The peak to peak magnitude of the signal is displayed and defined as the maximum distance between two points of the signal in the Lissajous, and as the distance between the point with the highest value and the furthest point from this for absolute channels. The angle made by the straight line joining the calculated points to obtain the peak to peak value is also displayed.

VVM, Maximum Vertical Volts — Measures the vertical distance in volts which separates the point of the minimum ordinate and the point of the maximum ordinate of the signal. The angle corresponds to the angle of the peak to peak volts mode.

VHM, Maximum Horizontal Volts — Measures the horizontal distance in volts which separates the minimum abscissas point and the maximum abscissas point of the signal. The angle corresponds to the angle of the peak to peak volts mode.

VMP, Positive Volts Measurement — Measures the distance in volts which separates the point of the maximum ordinate and the average value of the signal. The angle corresponds to the angle of the peak to peak volts mode.

Sludge Measurement Mode — Measures the maximum slope angle between points situated at a distance of three samples and in the peak to peak sense. When this mode is activated the circles of the Lissajous window are placed on the points, which make up the straight line the angle of which is the maximum slope angle, the voltage between both angles is measured.

MaxRate Mode — Measures the maximum rate of transition displayed in voltage and degrees.

With regard to the measurement of thickness loss, depending on the mode chosen as on the calibration curves made for each channel, the corresponding percentage or loss of thickness will be displayed.

Amplitude — Clicking on this button changes the shape of the cursor indicating that the amplitude of the representation of the signal is to be modified. Left clicking with the mouse in the Lissajous area and dragging it towards the centre decreases the size of the signal. On the other hand, if it is dragged outwards, the size of the signal will increase. The amplitude is taken as the value occupied by the signal as a percentage compared with the size of the Lissajous window.

Rotation — Clicking on this button changes the shape of the cursor indicating that the rotation of the signal is to be modified. By left clicking with the mouse on the Lissajous area and dragging it, the signal of interest will rotate, sweeping through 0 to 360 degrees.

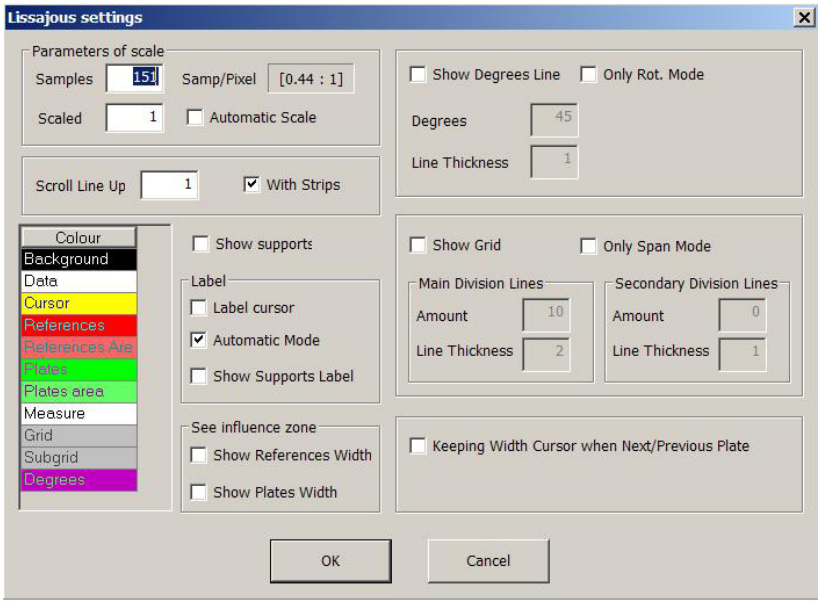


Figure 76 Lissajous settings

Properties — Establishes a series of characteristics for the Lissajous window (whether or not there are strips associated), it establishes the scale of the strips, the number of samples moved by the cursor when clicking on the scroll bar.

Double/Half — Left clicking with the mouse on this button increases the amplitude of the signal by 50%; right clicking with the mouse decreases the size by 50%.

Lissajous Area — Shows the eddy current signals in Lissajous format.

Associated Strip. Shows the horizontal and vertical components which make up the Lissajous.

Cursor — This is made up of three horizontal lines which define the area of influence and the current cursor position. The area of influence is defined by external lines and the current position is the central line. To displace the cursor over the strip associated with the Lissajous, hold the left button of the mouse down and move it across the window of the associated strip.

Scroll Bar — Left clicking with the mouse on the scroll bar moves the cursor through the data. This can also be done by using the up or down arrows on the Scroll Bar.

Scale — In the lower part of the strip chart the user is informed of the display scale factor for the strip associated with the Lissajous. This value indicates the number of samples represented on the associated strip.

Associated Strip

- Right button. Clicking and moving the mouse allows the user to enlarge the area of influence of the cursor. Changes in the size of the window of the cursor define the amount of data that is displayed in the Lissajous window.
- Shift + Left Button. Pressing both simultaneously adds or deletes a mark in the position of the cursor.
- Left Button. This moves the cursor to the desired position. If the left button is held down while the mouse is moved the cursor will move dynamically.

Lissajous

- **Right Button** — Balances the signal, centering it. If the button is held down and the mouse moved, the Lissajous signal moves.
- **Left Button** — If clicked in evaluation mode, it modifies the value of the points which are used for the calculation of the measurements (circles which appear in the Lissajous figure). The point which is closest to the cursor is the one which changes position.

9.4 Calibration Curves

In this window, the calibration curve selected in the measurement modes toolbar is shown. Here, the user can choose the channel and display the applicable calibration curve for each channel- the curve has been generated using the calibration control within the *Curves* section.

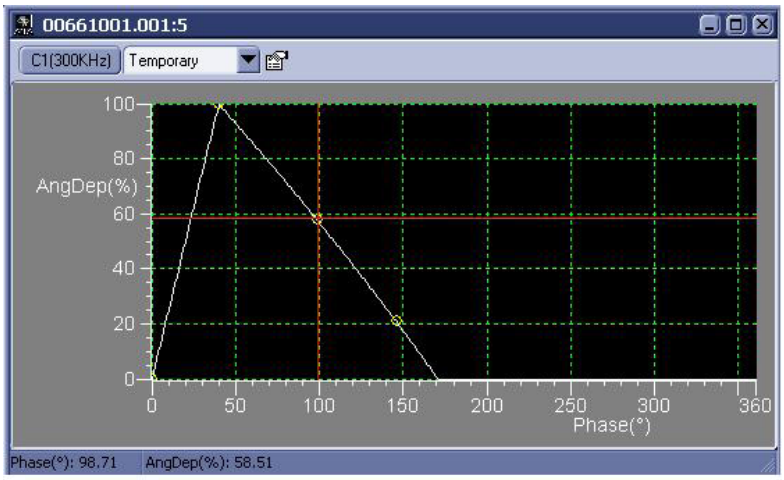


Figure 77 Calibration Curve View

9.5 1D View

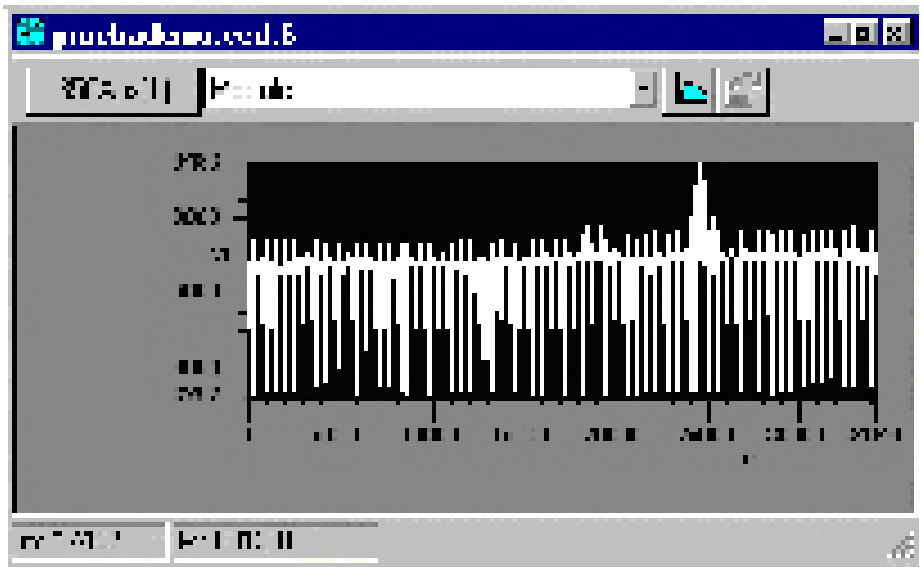


Figure 78 1D View

The following are the different areas of the window:

Button Bar — Includes the following buttons (from left to right)

Change Channel — Clicking on this button with the left or right buttons of the mouse displays the different EC channels corresponding to a specific item being tested. Information on the channel frequency is displayed together with whether the channel is absolute or differential.

Method Selection — Includes the following modes: Vertical Component, Horizontal Component, Module, Phase, Rotated Horizontal Data, Rotated Vertical Data, Rotated Filtered Horizontal Data, Rotated Filtered Vertical Data, Filtered Added Raw Data, Filtered Horizontal Raw Data, Filtered Vertical Raw Data, Filtered Horizontal Data, Filtered Vertical Data.

Location of Structures 10

10.1 Location of Structure

To access the structures location window, click on the Supports menu and select Recognition parameters.

The recognition of structures is based on the parameters set by the user that will define the signal detection thresholds.

The Supports Recognition Parameters window is made up of 5 tabs. The first four, Start End tube Detection, Tube Sheet Detection, Supports Detection and AVB Detection, are used to determine the detection thresholds for the structures in a given component, while the Identification window specifies certain general parameters for correct structure identification.

The lower part of the window contains a button bar with the following options:

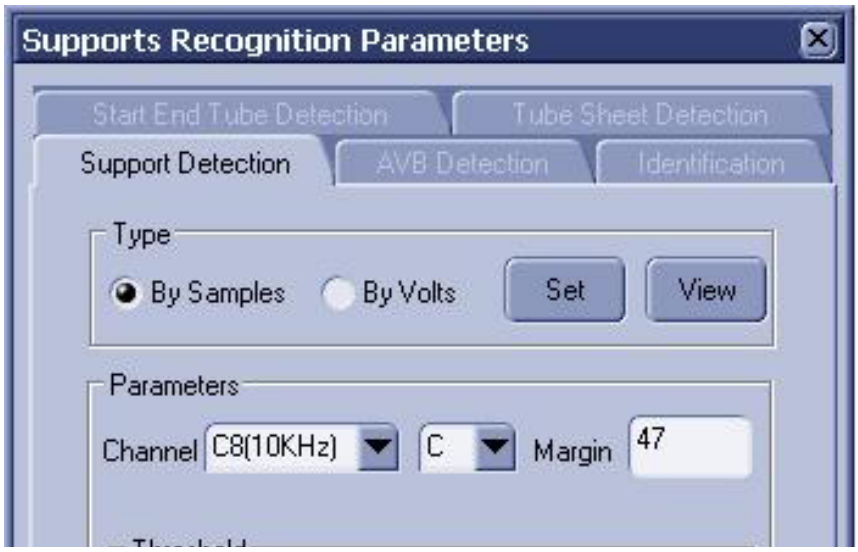
Apply — Used once for the input parameters are considered to be valid.

Close — Closes the window and ignores the changes made.

The support detection/identification process follows the following steps:

1. The tube end signals are detected (threshold 1)
2. The tube sheet signals are detected (threshold 2)
3. The support signals are detected (threshold 3)
4. The avb signals are detected if used (threshold 4)
5. The signals are labeled in function of the real distances between supports specified in the steam generator model and having into account a certain tolerance.

The different tabs included in the Supports Recognition Parameter window are described below.



10.2 Tube End Detection Parameters

This dialog determines the parameters that will be used by the system for the detection of tube end signals.

The type of detection threshold that is to be calculated may be based on samples or volts. Depending on the option selected, different parameters will be activated. To help establish these parameters, a button identified as Set is included, which automatically fills in the parameters.

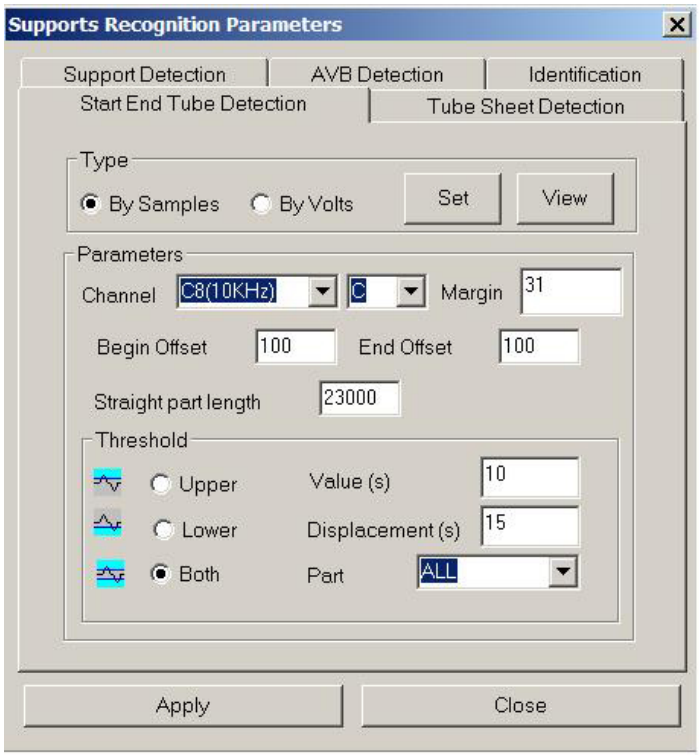


Figure 81 Supports Recognition Parameters

To accomplish this, position the cursor on a tube end signal and click on Set.

The parameters described will automatically be filled in.

Parameters involved in threshold calculation

Channel — This indicates the channel to be used to detect Tube end signals and the mode of the detection threshold calculation: if both components are required (C) or only one of them, horizontal (H) or vertical(V).

Margin — This represents the minimum size of a support plate. If the search detects signals separated by a distance of less than the “margin”, both are considered to be the same plate.

Input Offset/Output Offset — This serves to specify offsets that are applied to the tube end signals, and used to define the area in which the rest of the structures should be found.

Length Straight Section —Represents the distance, expressed in samples, between the tube sheet and the last support plate prior to the beginning of the U-Bend section.

Type of Threshold — Selection of signal detection thresholds between the upper, the lower or both.

Height/Volts — Represents the value of the threshold. If the threshold has been selected by samples, the calculation will be on the basis of the following expression:

$$\overline{X} \pm \text{Height} * s$$

where the average and standard deviation are calculated on the basis of the set of data specified in Part. If the threshold has been selected on the basis of volts, the input value will represent the threshold measured in volts directly.

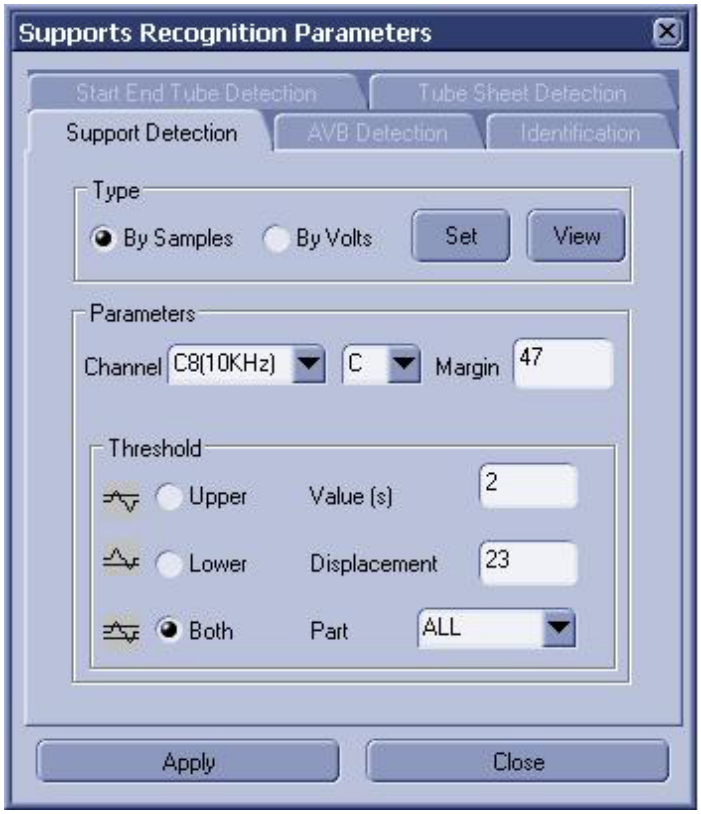
Displacement — number of data points for definition of the filter to be applied to the search data. This is not applicable in the case of detection by volts.

Part — Number of samples (with respect to the total number of samples) involved in calculation of the average and standard deviation, counted as from the central sample and to both sides of it. (All, Half, Third, others). This is not applicable in the case of detection by volts.

10.3 Tube Sheet Detection Parameters

This dialog determines the parameters to be used by the program for the detection of tube sheets.

This dialog determines the parameters used by the program for the detection of supports. The type of detection threshold calculated may be based on samples or volts. Depending on the option selected, one type of parameter or another will be activated.



Figue 82 Support Detection Parameters

The Set button is available to help establish these parameters, this automatically fills in the parameters. To accomplish this, place the cursor on a tubesheet signal and click on Set. The parameters described on the following page will automatically be filled in.

Channel — Indicates the channel used to detect the signal(s) of interest and the mode of the detection threshold calculation: if both components are requested (C) or only one of them, horizontal (H) or vertical(V).

Margin — Represents the minimum size of a plate. If the search detects signals separated by a distance of less than the “margin”, both are considered to be the same plate.

Type of Threshold — Selection of signal detection thresholds using either the upper signal lobe, the lower signal lobe or both.

Height/Volts — Represents the value of the threshold. If the threshold has been selected by samples:

Displacement — number of points for definition of the filter to be applied to the search data. This is not applicable in the case of detection by volts.

Part — Number of samples (with respect to the total number of samples) involved in calculation of the average and standard deviation, counted as from the central sample and to both sides of it. (All, Half, Third, others, ...). This is not applicable in the case of detection by volts.

Displacement — number of points for definition of the filter to be applied to the search data. This is not applicable in the case of detection by volts.

Part — Number of samples (with respect to the total number of samples) involved in calculation of the average and standard deviation, counted as from the central sample and to both sides of it. (All, Half, Third, others, ...). This is not applicable in the case of detection by volts.

10.4 AVB Detection Parameters

This dialog determines the parameters to be used by the program for the detection of anti-vibration bars.

The type of detection threshold to be calculated may be based on samples or volts. Depending on the option selected, a parameter will be activated.
The Set button is available to help establish these parameters, automatically filling in the parameters. To accomplish this, place the cursor on an anti-vibration bar signal and click on Set. The parameters described below will automatically be filled in.

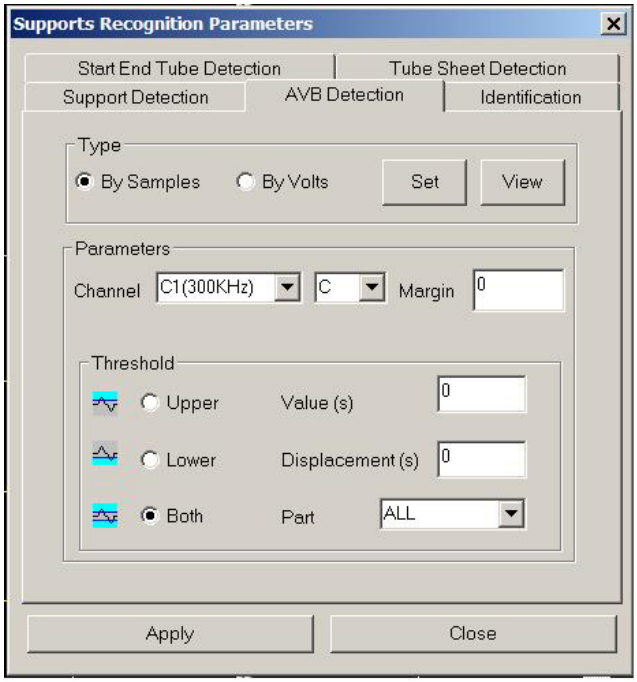


Fig. 83 AVB Detection

Parameters involved in threshold calculation.

Channel — This indicates the channel to be used to detect the anti-vibration bar signals and the mode of the detection threshold calculation: if both components are requested (C) or only one of them, horizontal (H) or vertical(V).

Margin — This represents the minimum size of an anti-vibration bar. If the search detects signals separated by a distance of less than the “margin”, both are considered to be the same AVB.

Type of Threshold — Selection of signal detection thresholds between the upper, the lower or both.

Height/Volts — This represents the value of the threshold. If the threshold has been selected by samples.

Displacement — Number of points for definition of the filter to be applied to the search data. This is not applicable in the case of detection by volts.

Part — Number of samples (with respect to the total number of samples) involved in calculation of the average and standard deviation, counted as from the central sample and to both sides of it. (All, Half, Third, others, ...). This is not applicable in the case of detection by volts.

10.5 Support Identification Parameters

The following parameters are specified in this dialog:

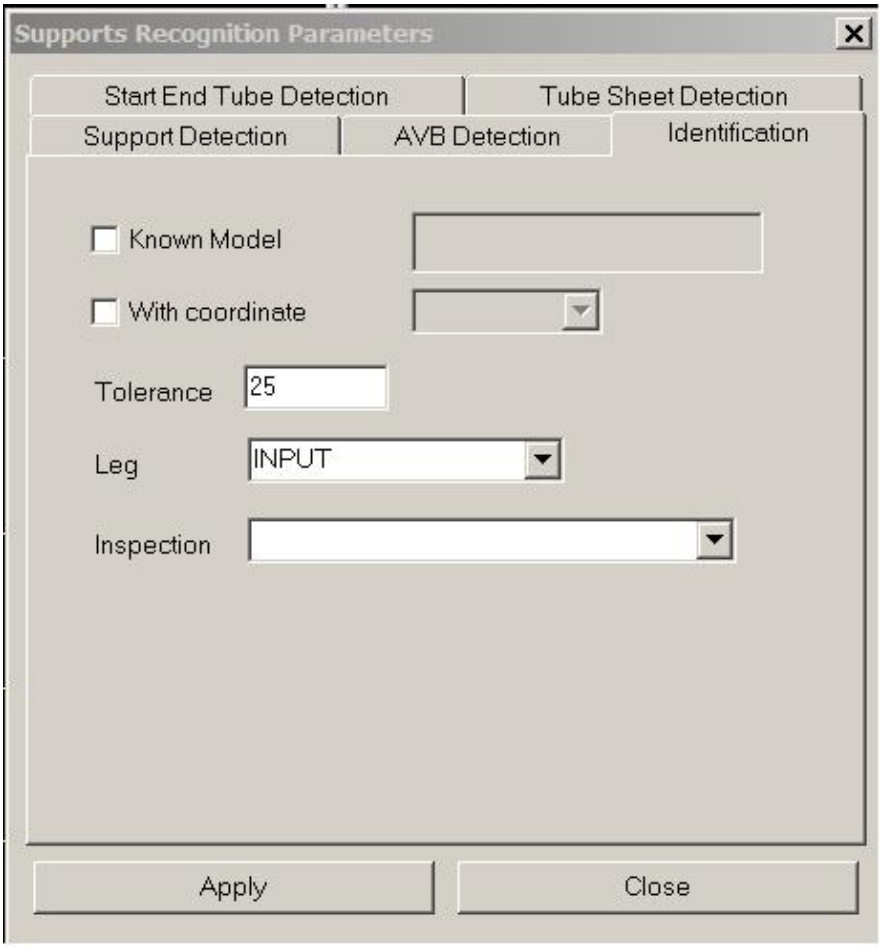


Figure 84 Support Identification Parameters

Model — Option under development.

With Coordinate — Option not developed.

Tolerance — Margin of error used by the recognition algorithm to identify previously detected signals imply a percentage of the actual distances between supports specified in the component model.

Units — This serves to determine the units in which the location of an indication will be expressed (distance between the cursor and the closest support plate). This may be in millimeters, inches and other units).

Inspection — This value indicates the section of the tube inspected. The values that may be used are: the entire tube, half the tube, straight section only, straight section plus u-bend and rolled zone only. This value will automatically computed if this option remains without data (blank).

Leg — This indicates in which leg of the component the acquisition has been performed. This indicator should remain without data unless the information at the moment of acquisition is erroneous and is to be corrected.

Calibration Procedure 11

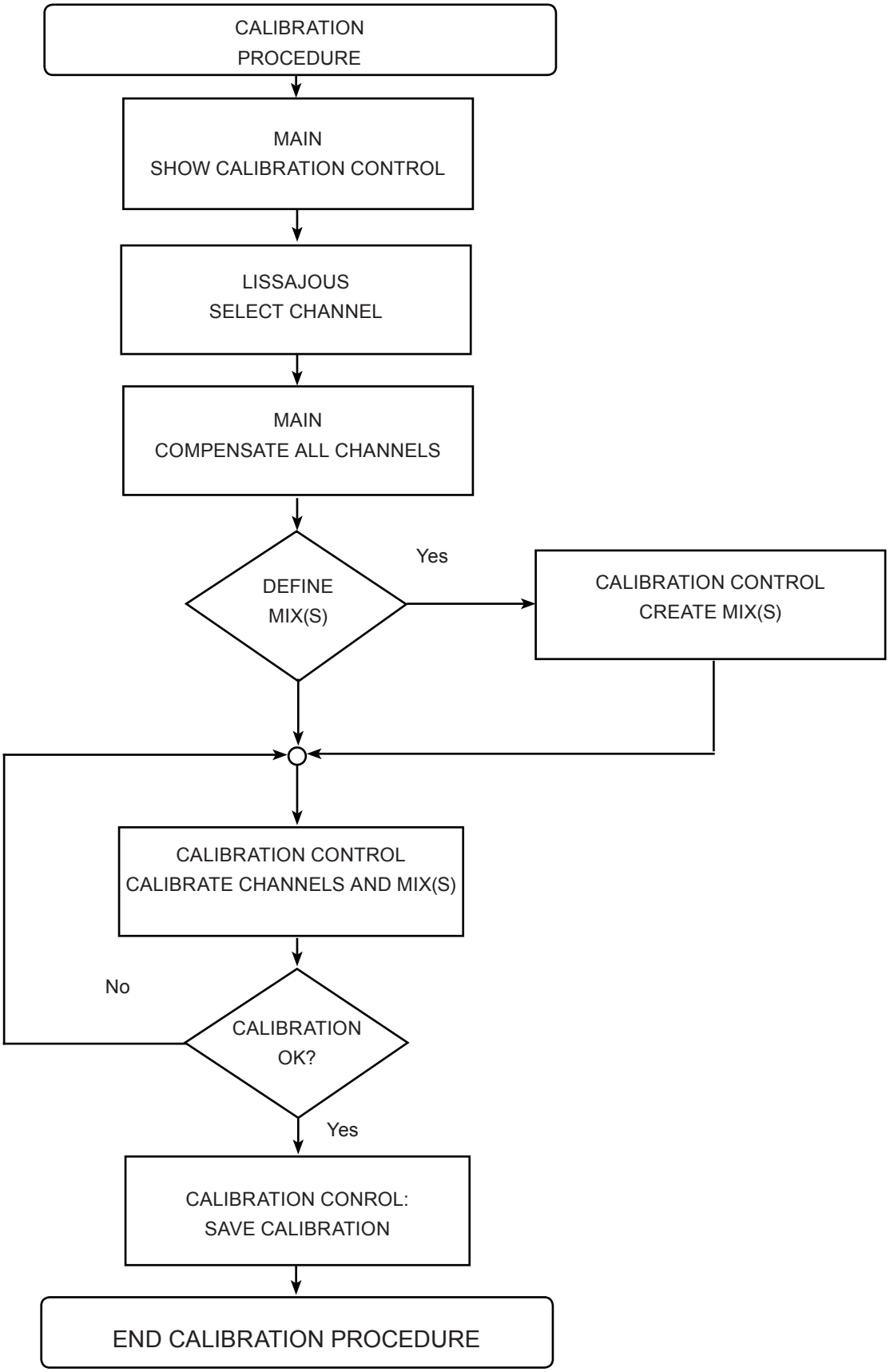
11.1 Operating Procedures

This section will describe a typical operating procedure for data analysis.

The operating procedures are shown in the form of flow diagrams, in accordance with the following standards:

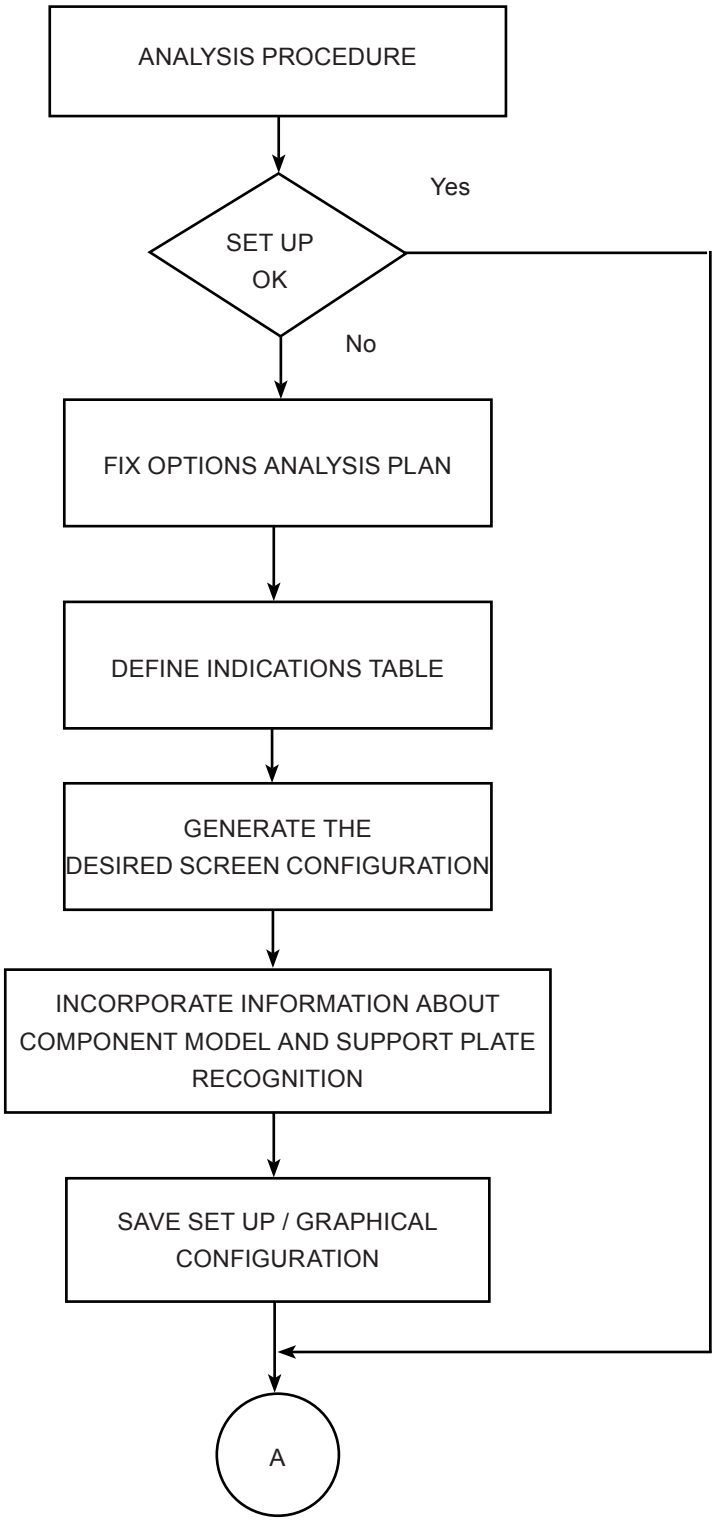
11.2 Calibration Procedures

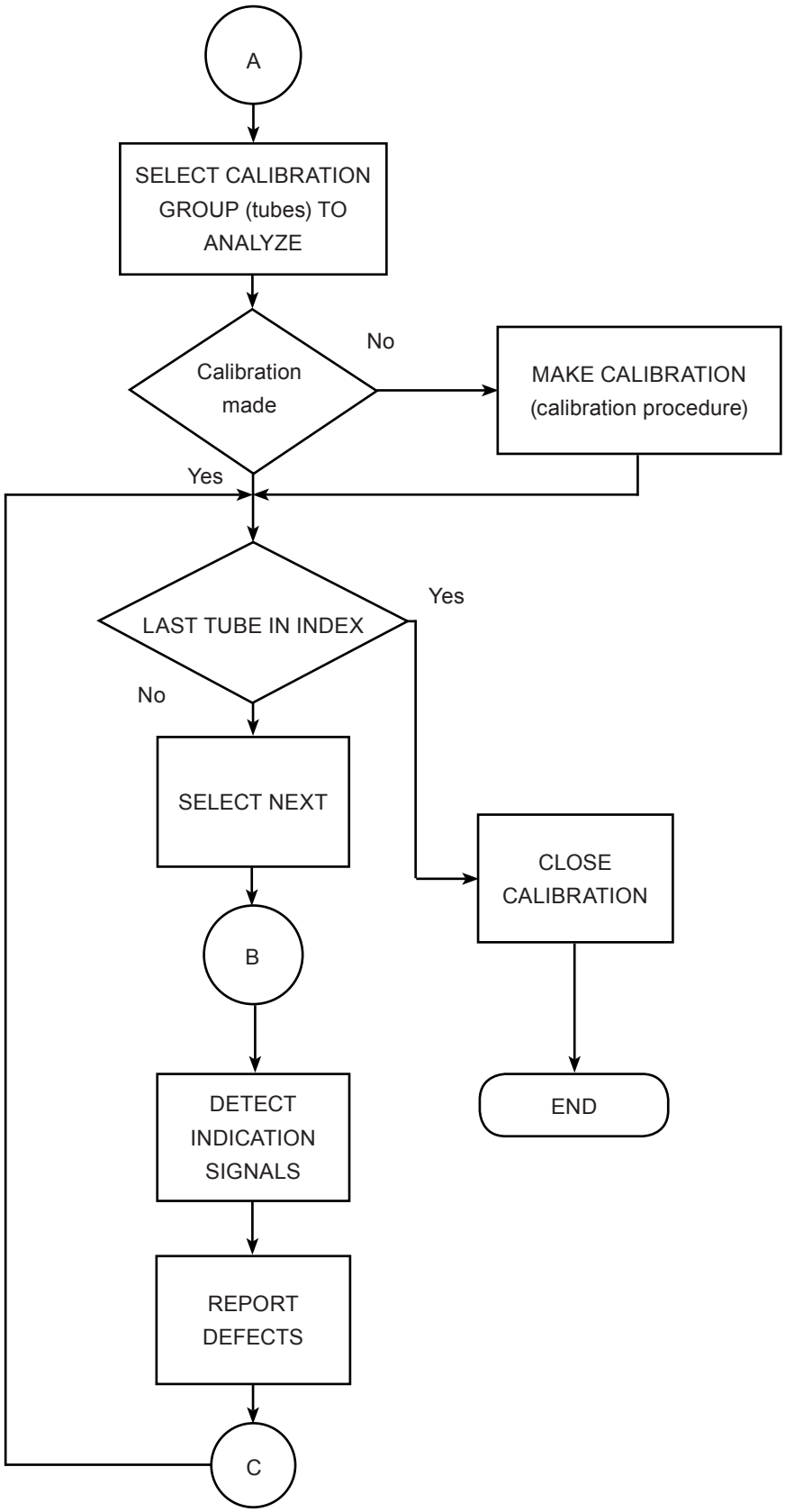
To calibrate the system, it is necessary to have the acquisition data displayed on screen. The following sequence should then be carried out:


CALIBRATION
PROCEDURE
MAIN
SHOW CALIBRATION CONTROL
LISSAJOUS
SELECT CHANNEL
MAIN
COMPENSATE ALL CHANNELS
DEFINE
MIX(S)
Yes
CALIBRATION CONTROL
CREATE MIX(S)
CALIBRATION CONTROL
CALIBRATE CHANNELS AND MIX(S)
No
CALIBRATION
OK?
Yes
CALIBRATION CONROL:
SAVE CALIBRATION
END CALIBRATION PROCEDURE

11.3 Analysis Procedure

The following diagram shows a typical analysis sequence.

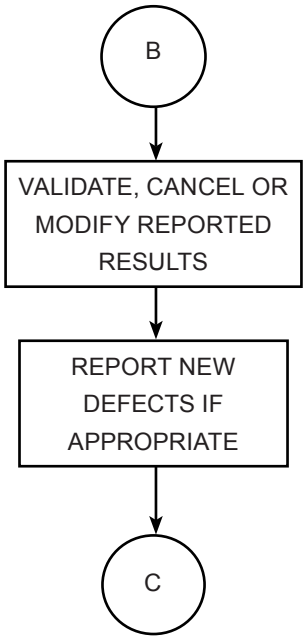



A
SELECT CALIBRATION GROUP (tubes) TO ANALYZE
Calibration made
No
MAKE CALIBRATION (calibration procedure)
Yes
LAST TUBE IN INDEX
Yes
No
SELECT NEXT
CLOSE CALIBRATION
B
DETECT INDICATION SIGNALS
END
REPORT DEFECTS
C

11.4 Supervision Procedure

Essentially, this is the same as what has been commented above for the analysis, with the difference that only records considered to be reviewable are included, as defined in the chapter on Analysis and Supervision.

The main difference is found in the operations to be performed between points B and C, as shown in the diagram.



Appendix A

Appendix A

Menu Detachment of the General Application

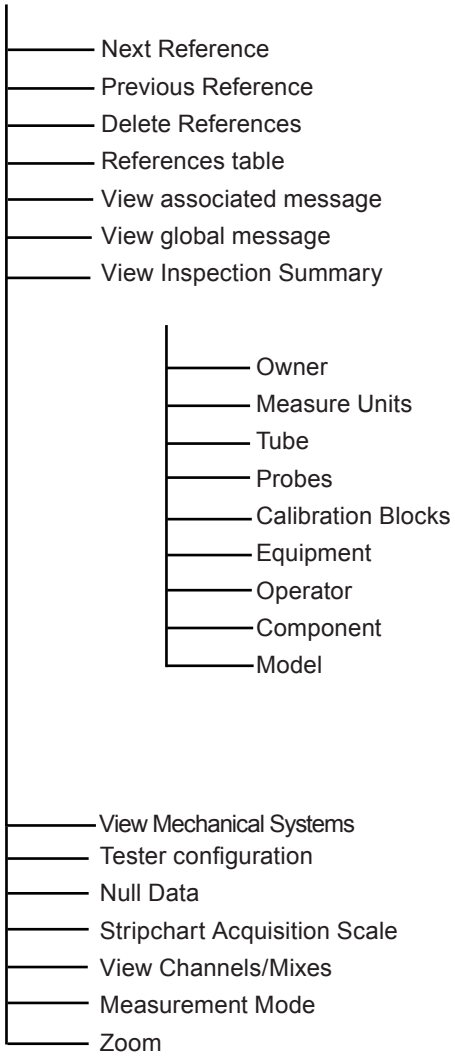
File

- Open
- Read
- Save as
- Close
- Print
- Preview
- Print Setup
- Page Setup
- Recent files
- Exit

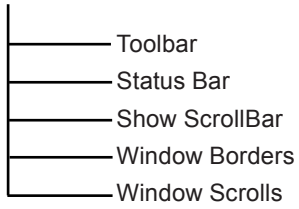
Analysis Plan

- Macros
- New Analysis Plan
- Show current plan
- Save Setup
- Save Setup as
- Change Analyst
- Calibration Group Selection
- Next Tube
- Previous Tube
- View Index
- When closing calibration make DB backup
- Indications Table
- When reporting NDD read previous register
- See warning messages in calibration reading
- See warning messages in support recognition
- Current tube indications
- Current calibration indications
- Historical report

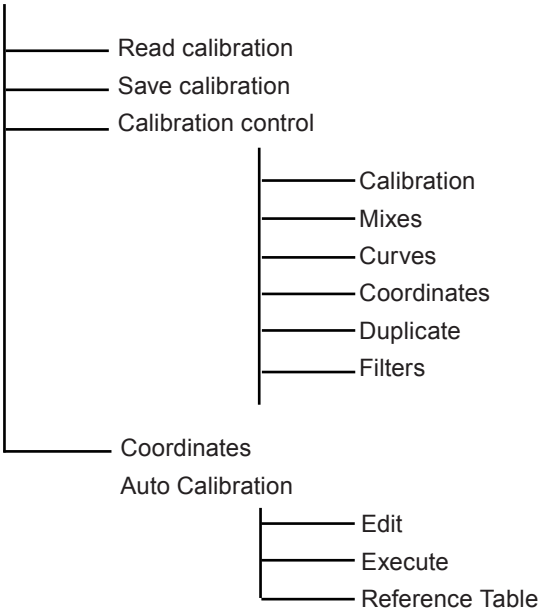
Document


Next Reference
Previous Reference
Delete References
References table
View associated message
View global message
View Inspection Summary
Owner
Measure Units
Tube
Probes
Calibration Blocks
Equipment
Operator
Component
Model
View Mechanical Systems
Tester configuration
Null Data
Stripchart Acquisition Scale
View Channels/Mixes
Measurement Mode
Zoom

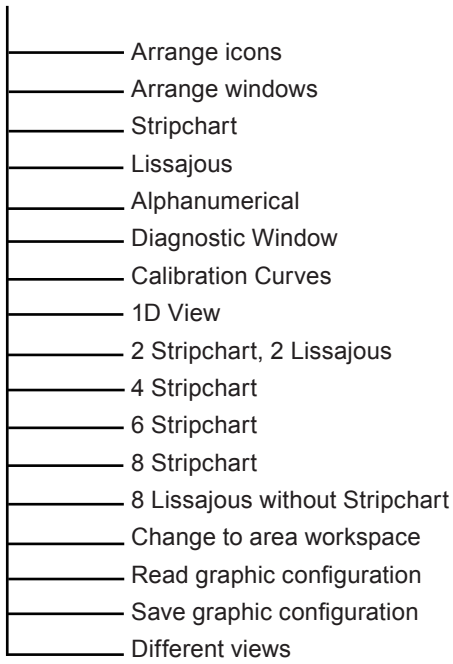
View



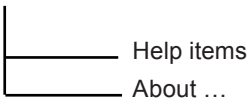
Calibration



Window



Help



Appendix B

WEEE

GE Inspection Technologies is an active participant in Europe's Waste Electrical and Electronic

Equipment (WEEE) take-back initiative, directive 2002/96/EC.

The equipment you purchased required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment. In order to avoid the dissemination of those substances in our enviroment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. If you need more information on the collection, reuse and recycling systems, please contact your local or regional waste administration.

Visit http://www.geinspectiontechnologies.com for take-back instructions and more information about this initiative.

Service Centers

USA
GE Inspection Technologies
50 Industrial Park Rd.
Lewistown, PA 17044
T: 717.242.0327
F: 717.242.2606

Germany
GE Inspection Technologies
Robert-Bosch-Strasse
T: +49.2233.601.111
F: +49.2233.601.555

France
GE Inspection Technologies
68 chemin des Ormeaux
F-69760 Limones
T: +33.472.179.216
F: +33.472.179.254

Spain
GE Inspection Technologies
C/San Máximo 31,
Planta4, Nave 6 28041
Madrid
T: +34.915005990
F: +34.915006062

China
GE Inspection Technologies
1800 Cai Lun Road
Zhang Jian Hi-Tech ParkShang-
hai 201203 PR
China
T: +86.21.5050.4666 ext.
F: 717.242.2606

Japan
GE Inspection Technologies
3-8-1 Higashiyama
Meguro-ku,Tokyo 153-0043
Japan
T: +81.3.5724.7323
F: +81.3.5724.732

UK & Ireland
GE Inspection Technologies
892 Charter Avenue
Canley Coventry CV4 8AF
T: +44.2476.47.25.63
F: +44.2476.46.80.15

www.ge.com/inspectiontechnologies